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EXPERIENCES IN CEREBRAL SURGERY.*

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THE most frequent causes of death following operations for tumor of the brain are shock and sepsis. "Shock is responsible for 8 per cent. of the deaths in the tumors correctly and accurately diagnosed and successfully removed. Whereas, in operations in which the tumors are inaccurately diagnosed, not found, and not removed, shock is responsible for 37 per cent. of the deaths" (Horsley, *British Med. Journal*, Aug. 23, 1906). In an approximative way this shows the importance of shock in operations upon the brain. Sepsis, like shock, is an important cause of death, but more especially as a secondary infection. Primary infection—that is, an infection at the time of operation—is rare, but it is the experience of most surgeons that just in proportion as one must drain and the healing is to be by granulation tissue, the danger of infection will increase.

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Nothing is more striking than the security against infection given by a primary union, and the absolute uncertainty existing in cases drained. To overcome these important factors we try to shorten the time of operation, to limit the hæmorrhage, and to avoid drainage in any form.

During some years of an operative experience in cerebral surgery we have noticed that many operations are performed with instruments often imperfect in themselves, or in the use of which the surgeon is frequently not familiar. We have also observed that after the definite localization of a tumor or cyst the craniocerebral topography is so imperfectly applied, and the flap so badly fashioned, that the tumor or the disease, if not extensive or prominent, is not found until autopsy reveals it. It has been our aim to shorten the time for operation by overcoming these undesirable facts. We have therefore tried, first, to find an armamentarium upon which we could thoroughly rely, which would serve as well no matter how thick or thin the skull, and which would permit an exposure of the dura in the shortest possible time and with the best possible relation of the bone and the flap to the skull after replacement. We have used in a number of instances the trephine, and from its opening have cut away the bone with the rongeur or have cut out a bone flap with some specially devised bone forceps, chisel or fraise. We have always been cognizant of the objections to their use, namely, the imperfect application of the bone flap to the skull when replaced, permitting the bone to rest upon the dura rather than upon the surrounding bone.

Second, when chisels are used the repeated blows have, in thick skulls, been productive of considerable shock. These objections are avoided by the Gigli saw, which cuts from within outwards, and with a very narrow slit, so that when the bone is replaced, if the bevel is ever so slight, it will rest upon the surrounding bone and not upon the dura. Its application requires several trephine holes, and the passage of a guard or director from hole to hole. When the dura is tightly attached to the bone or the intracranial pressure is great this is a tedious process. Unless the saws are of the best quality

they not infrequently break at the most inopportune moment. We have used also the Van Arsdale saw, a circular saw shaped like a saucer, and intended to cut on a curve, the dura being protected by a guard which follows in the slot, having been introduced through a trephine opening. The objection we have found to this saw was that the guard and the saw were very apt to jam and stick unless the particular arc for which the saw was designed was accurately followed. We have used also the Stellwagen trephine, a trephine having cutting teeth mounted on a movable arm which can be adjusted at any distance from the central fixed point. Larger or smaller osteoplastic flaps can thus be cut. The objection we have to this is that which we entertain against all trephines, including the large Horsley trephines, namely, that they do not cut the skull accurately and rapidly, nor allow of variation enough in their size to be of practical value in osteoplastic flaps.

We have used also Powell's saw in combination with the trephine. This has been quite satisfactory. The cutting depth is regulated by an adjustable shoe controlled by a screw. The screw, however, is apt to become loose and thus change the depth at which the saw will cut. We have used in the same way the Marsland saw, but see in it no advantage over other saws. The mechanism of the guard and the handle is good.

We have also used the Sudeck saw, but we consider it unsatisfactory, as it has no guard to regulate its depth in cutting nor are the handles so placed as to render it easily manipulated where a thick scalp is present.

We have used in addition the Doyen circular saw, and the method of using it has appealed to us more than any other saw. The mechanism is simple, and the individual parts are strong and do not get out of order.

From 1900 up to about a year ago many of the operations on the skull have been performed by us with the aid of burrs, drills, and circular saws, the power being furnished by a quarter horse-power motor through a flexible shaft which was made up of links, and was considerably heavier, stronger and more flexible, with less vibration and jar, than those made

of twisted wire. The entire shaft was sterilized by being disconnected from the motor, wrapped with a gauze bandage, and put in a bag or towel. The disadvantage of this apparatus was that, owing to its weight, it was not easily transported. The shaft, though flexible, had a certain fixed length which oftentimes, seriously interfered with the free manipulation of the cutting tool, and when bent at a slight angle, owing to the increased friction, gave a peculiar jar and vibration to the cutting tool. To overcome some of these objections, we make use of the following implements: *First,* a small motor, of such size and weight that it can be held by the operator himself, giving him perfect control of the cutting tool and also of the power (Plates I and II). The tools are connected by means of an appropriate chuck directly to the end of the armature, thus obviating all loss of power which occurs when a flexible shaft is used (Plate V, Figs. 1, 2, 6, 12).

To provide for the proper sterilization of the apparatus, a thin metal casing in three pieces is accurately and securely fastened to the motor, completely enclosing it, yet readily removable. This casing, with about 10 feet of ordinary flexible electric light wire is removed from the motor and boiled. The interior is dried with sterile gauze and then replaced on the motor, thus making a perfectly aseptic exterior. The method by which the sterile casing is applied to the motor is as follows. The motor is held with a sterile towel in the palm of the left hand, the end *A* being up. (See Plate II.) The portion *B* is now screwed down as far as possible and grasped by the right hand, which holds the motor, while the left hand being free, drops the towel, picks up the other portion *C* (which is still sterile inside and out) and slips it in place where it is securely held by screwing down the knob *D*.

During the operation the motor is held as follows: The adjustable handle *E*, placed at right angle to the long axis of the motor, furnishes a firm convenient grasp for the right hand. The knob *D* is grasped with the left hand. The left thumb or left index finger may be used to manipulate the switch which makes and breaks the current. Occasions may

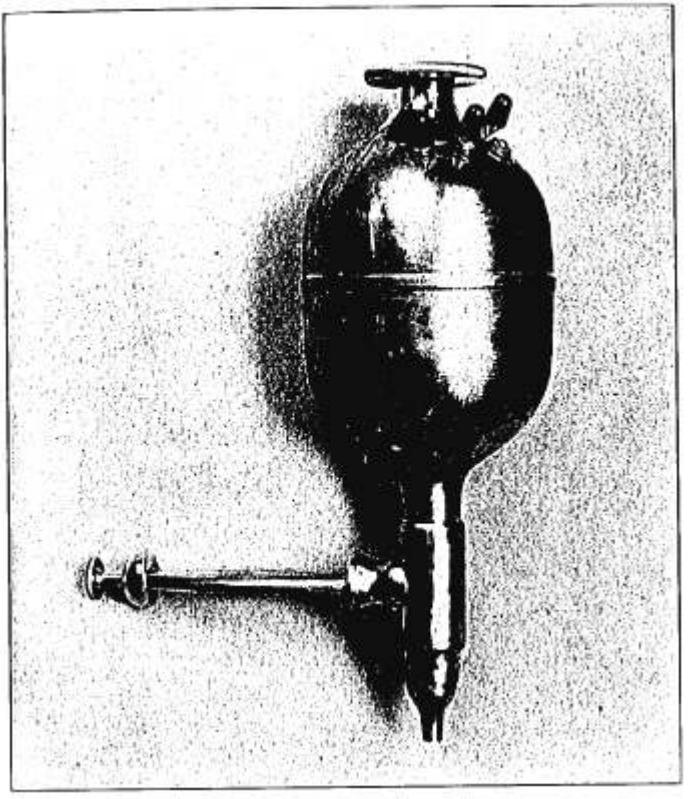

PLATE I.—Motor and casing complete. Weight, 8½ pounds. One-eighth horse-power.

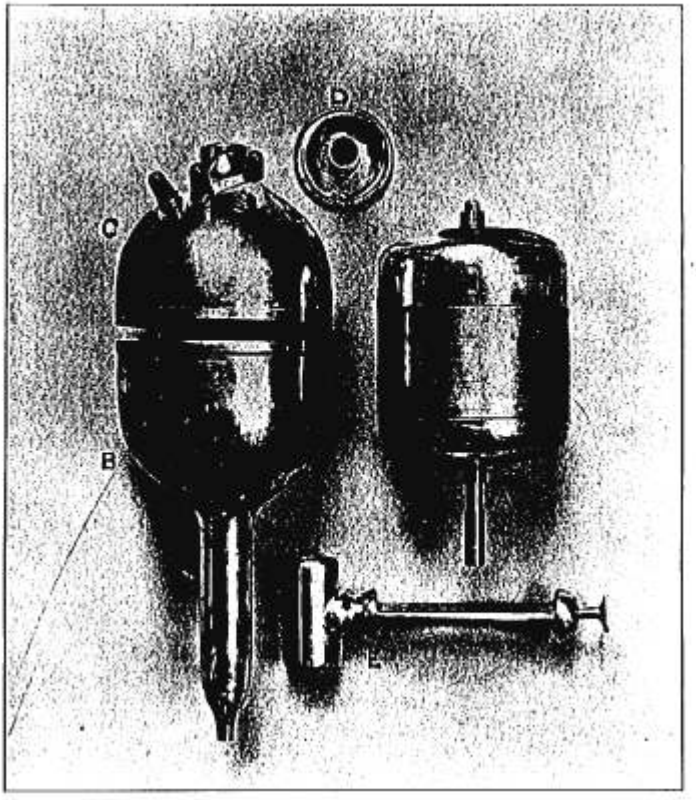

PLATE II.—Weight, with casing complete, 8½ pounds. Weight, without casing, 6¼ pounds. Length, 10½ inches. Diameter, 4⅛ inches. Circumference, 14¼ inches. Speed, 2400 revolutions per minute. Volts, 115. A direct current; shunt wound. About ⅛ horse-power.

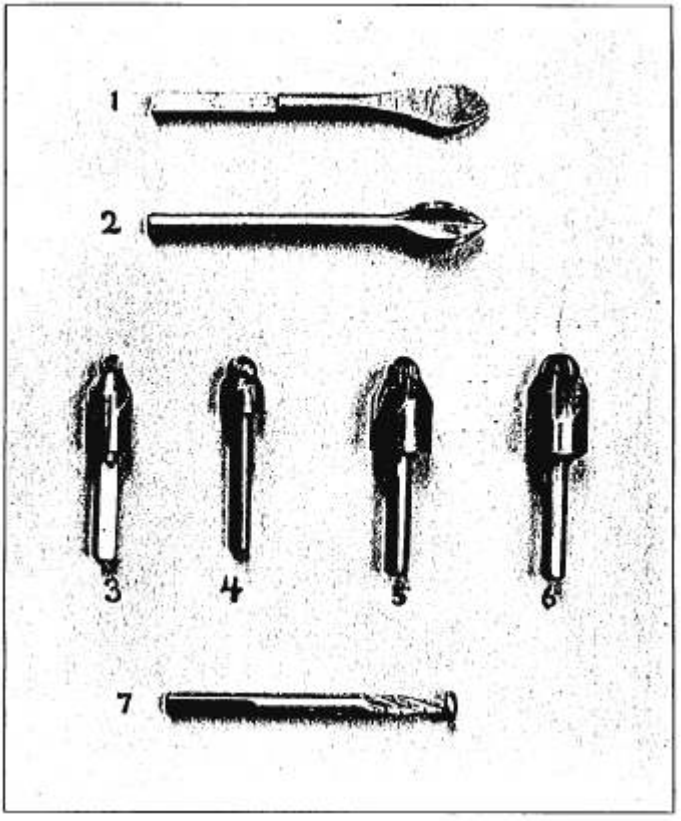

PLATE III.—1, 2, Conical cutters. 3, 4, 5, 6, Ball mounted in tip of cone. 7, Fraise. 1 followed by 3 is the usual combination.

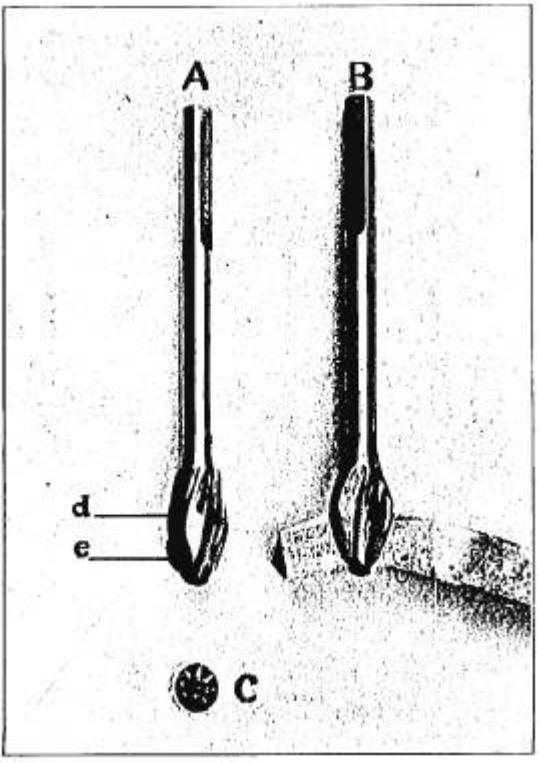

PLATE IV.—A single cutter combining the functions of 1 and 3, Plate III. *A*, *d*, greatest diameter of cutter, 10 mm. Distance from *d* to tip, 11 mm. Blades between *d* and *e* are serrated to facilitate cutting. Distance from *e* to tip 4 mm. *B*, manner in which cutter enters skull. *C*, end view of cutter.

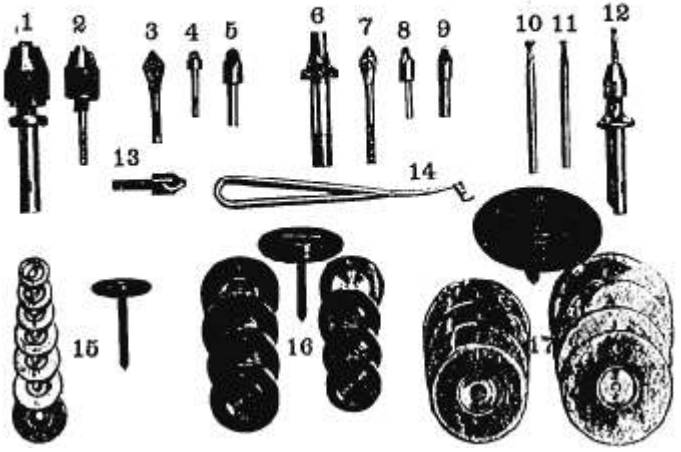

PLATE V.—1, 2, 6, Chucks. 3, 7, Conical cutters. 4, 5, 8, 9 Ball and cone cutters. 10, 11, 12, Fraises. 14, Measure. 15, 16, 17, Circular saws with guards.

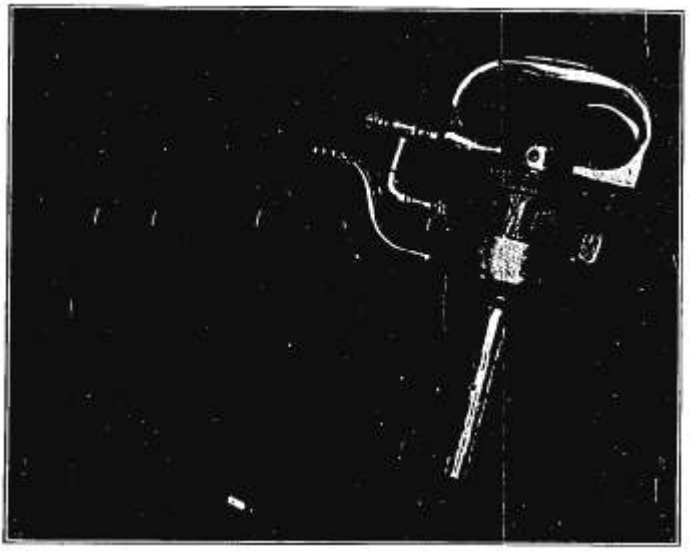

PLATE VI.—Compressed-air motor fitted for using the same cutting tools as the electric motor. Weight, about six pounds. Requires 80 to 90 pounds air pressure. Motor and hose can be boiled.

arise when the position of the hands holding the motor will have to be reversed, but this can be easily done, and with the same degree of certainty of action in the instrument.

Secondly, a cutter has been devised after considerable experiment with all forms of drills and burrs which we could find. The shape of the cutter permits one to enter the cranial cavity without fear of suddenly pushing through the vitreous plate. The serrations upon the blades between *d* and *e* (Plate IV, Figures *A* and *B*) allow one to appreciate with the less rapidly cutting end, as with a probe, the difference in density of the outer plate, the diploe and the inner plate of the bone. One can appreciate this even by watching another person using the instrument.

Formerly we made use of two instruments instead of this single cutter,—the one a drill, the other a burr set in the end of a cone, which latter allowed the reaming of the cavity and at the same time prevented the burr from suddenly passing through and injuring the dura. We have of late been able to combine these two instruments in one, and feel that thereby we have shortened measurably the time in entering the the skull. This instrument is shown in Plate IV and the two separate instruments as devised by us and used formerly to a large extent are shown in Plate III, Figs. 1, 2, 3, 4, 5, 6, and Plate V, Figs. 3, 4, 5, 7, 8, 9, 13.

Thirdly, a circular saw. Upon this saw we make use of Doyen guards, each being stamped with the number of millemetres it will permit the saw to cut. We prefer this guard to others because it is strong; it is simple and it is easily sterilized. The saws vary in size from 1 to 3 inches in diameter; the larger saws being used when the tissues of the scalp are thick, and the narrower ones when the tissues of the scalp are thinner (Plate V, Figs. 15, 16, 17).

The other instruments which we make use of are those that are commonly used in all osteoplastic operations upon the skull, such as the retractors, the spud-like instruments for the elevation of the bone flap, the narrow, slender osteotome, periosteum elevator, and a millimetre measure for the depth

of the skull (Plate V, Fig. 14). Where an accurately fitting bone flap is not required or where the bone is to be removed completely and not replaced or where an opening in the skull is to be enlarged, a fraise may be used (Sudeck's, Cryer's, or Sykes'). If no opening exists, a hole is drilled of sufficient size to admit the button on the fraise. The fraise is inserted and forced to cut in the direction desired. We have modified the ordinary fraise by having cutting teeth or serrations upon the blades, and it seems to improve its efficiency to a marked extent. We object to the use of the fraise, however, except under the conditions above mentioned, because it cuts a wide slot which prevents an accurate fitting of the bone after its replacement. It cuts slowly, with considerable heating, especially where the bone is over 6 millimetres in thickness. (See Plate III, Fig. 7, and Plate V, Figs. 10, 11, 12.)

We have used in a few instances a motor run by compressed air, the same chuck and tools being used in the motor with compressed air as we have used in the electric motor. This whole apparatus, with the tubing, can be boiled. The motive power must be compressed air, at a pressure of 75 to 90 pounds, in order to have it efficient.

In the second place, we must determine upon a method of cranio-cerebral topography which is thoroughly reliable and practical. Contrary to the opinion expressed by many surgeons, I believe that cranio-cerebral topography deserves an extensive application in the surgery of the brain. The Chipault method, which I have used for eleven years and have tested upon over 200 cadavers, and in some 40 operations upon the living, is the most comprehensive and generally correct of all the systems. It adapts itself to all varieties of skull, no matter whether they be the result of race, age or individual peculiarity. The constant use of this system renders one quite adept in locating to a nicety the sulci and convolutions, and the various sinuses, without measurements; but this is not to be expected in everyone, and some trustworthy system must be at hand. (Chipault's "Chirurgie Opératoire du Système Nerveux," p. 121, vol. i.)

PLATE VII.—1. Motor and sensory disturbances, lower extremities. 2. Motor and sensory disturbances, upper extremities. 3. Motor and sensory disturbances, face, tongue, jaw, pharynx, vocal cords. Motor aphasia in right-handed people and vice versa. 4. I. Movements of the body (posterior part of the first frontal convolution). II. Movements of the head and neck (posterior part of second frontal convolution). III. Associated movements of the eyes and head. 5. Tactile and muscular sensibility. 6. Hemianopsia and word-blindness, agraphia and paraphasia. 7. Intelligence. 8. Storage of visual images (cuneus, lingual lobe and calcerine fissure cannot be seen). 9. Audition. 10. Images for words heard and musical tones (left side). In this same region on both sides, the sensory motor auditory centre exists. 11. Nasion. 12. Inion. 13. Retro-orbital tubercle.

The internal frontal convolution lies in the longitudinal fissure, opposite the superior frontal convolution. The para central convolution lies in the longitudinal fissure opposite the ascending frontal, between the 45% and 55% points. The quadrate lobe lies in the longitudinal fissure opposite the ascending and inferior parietal convolutions, between the Rolandic and Sylvian lines, that is, the 55% and 70% points. The cuneus, lingual and the fusiform lobes, first, second and third occipital convolutions are between the 70% and 95% lines.

Plate VII is made from a specimen most carefully prepared by Drs. Ayer and Spitzka. The subject used was injected immediately after death with a strong solution of formalin under slight pressure. The Chipault measurements were then made upon the skull and the bone between the lines was removed, leaving the thin and narrow strips of bone to represent these lines. The skull was now bisected anteroposteriorly and the hardened brain was removed entire. From this brain a cast has been carefully prepared, and upon this cast has been painted the various points of localization as we use them. The cast has been substituted for the brain in the skull, and this drawing has been made from it. One can see from this drawing that, given any point of localization of value, a sufficiently large flap can be made which will have beneath its centre, or to one side of its centre if desired, the area in the brain to be exposed. Flaps accurately placed are of great advantage because one removal of bone is sufficient for the exposure of all possible eventualities. For the neurologist and for the surgeon such a flap permits a rapid and accurate orientation of the area to which the motor, sensory or sensorial symptoms have referred. For the patient it shortens the time of operation, it diminishes the hæmorrhage, and it avoids undue shock.

The great advantage of an accurate knowledge derived from this source can only be appreciated when searching for subcortical tumors or in dissecting out traumatic cysts with their irregular diverticula and their adhesions to the surrounding brain tissues.

It is our custom, therefore, to measure every scalp before it is cleaned for operation. The measurements are written down and at the time of the operation the lines are drawn with a fuchsin pencil or with tincture of iodine. After consultation with the neurologist the possibilities of the case are considered, and the flap is fashioned so as to best expose the area desired. After the bone flap is thus fashioned and the dural flap is made, the lines will show at a glance the fissures and convolutions desired. At any time the flap may be replaced,

and the position of the line upon the brain measured with the eye. If the disease or tumor can be located, the centre of the flap is usually over the point of localization. If the localization cannot be exactly determined, the operation becomes more or less exploratory, and the flap is cut so as to expose centre of the parietal or both sides of occipital or frontal or cerebellar lobes.

Thirdly, we are convinced, after quite an experience in cutting cranial bone flaps, that the best form of flap is one which obtains its blood supply from the temporal or occipital arteries. The supra-orbital and frontal arteries may be used, but they are not necessary.

Fourthly, the variations in the depth and density of the bones of the skull have shown us that the safest and quickest means of dividing the bones is to select the thinner portions as bases for the periosteo-osseous flaps, and to divide the thicker and denser portions with a saw. The variations in depth of the bones range between 1 mm. and 12 mm. in the adult. We have measured one or two skulls in which the temporal fossa has measured ½ mm. in depth. Some skulls have measured 12 mm. to 12½ mm. in the thickest portions, near the sagittal suture or in the occipital bone. We expect usually to find in the temporal fossa the thickness ranging from 2 mm. to 5 mm. Half way between the temporal fossa and the sagittal suture the usual variation in depth has been 5 mm. to 7 or 8 mm., while from this point to the median line the depth usually ranges from 7 or 8 mm. to 11 or 12 mm. This variation in measurements holds good for all parts of the skull from the frontal bosses to the superior curved line of the occipital bone. So that, if a line be drawn 1 cm. laterally to the sagittal suture from the frontal bosses to the superior curved line of the occipital bone, the varying depth will be from 7 to 11 mm. If a line be drawn half way between this line and the ridge bounding the temporal fossa from the frontal bosses to the superior curved line of the occipital bone, the usual depth of the skull will range between 4 or 5 and 6 and 8 mm. In the temporal fossa itself the variations will be from 1 to 4 or 5 mm.

From these measurements one can conclude that the thinnest part of the skull is in the temporal fossa, and that from the edge of this fossa the bone increases in thickness and density as it approaches the frontal bosses, the sagittal suture and the superior curved line of the occipital bone. Unfortunately, this increase in thickness and density is not always regular nor gradual, so that in the preparation for the saw one must drill enough holes to avoid a decided variation in depth. We have found that if the drill holes are within 4 cm. of one another one is reasonably certain of avoiding any great disparity. If such is observed, a third hole may be drilled between the two holes showing such disparity. The danger arising from this disparity in depth can be eliminated in this manner. Because the temporal fossa is thinner than the remainder of the convexity of the skull, all our bone flaps exposing the frontal, the parietal and the occipital regions of the brain are best and most easily made when the base of the flap is in the temporal fossa. This being the thinnest part of the skull, the breaking of the bone can be accurately determined and made without the great force necessary to break it in a thicker portion, and the uncertainty which exists of having the bone flap break in the middle and not at the desired point. This may occur, no matter how much care is used when a very thick bone is used for the base of the flap. All our flaps then radiate from the temporal fossa as a base. Frontal flaps have their bases in the anterior part of this fossa, parietal flaps in the middle of this fossa, and occipital flaps in the posterior part of this fossa.

Fifthly, after a flap is fashioned and the bone is removed, it may be replaced. The defect may be filled with bone from another individual, animal, or with a foreign substance. We prefer, in all cases, to replace the bone or to implant a foreign substance because this affords protection to the brain, it prevents hernia cerebri, it limits adhesions between the dura mater and the pia mater and the brain, and it secures the most rapid and perfect healing.

Of these methods, we prefer the autoplastic to the homo-,

hetero- or necro-plastic; we prefer the necro-plastic to the homo- or hetero-plastic.

Autoplasty is performed by the implantation of bone having a partial connection with the surrounding parts (Wolff: *Langenbeck's Archives,* No. 4, p. 183, 1863; Wagner: *Centralblatt fur Chirurgie,* No. 47, 1889) or by the implantation of bone completely separated from all connection with the surrounding parts (von Walther: *Langenbeck's Archives,* No. 4, p. 196).

The former method is preferred: First, because bone which is entirely separated from the periosteum and implanted usually undergoes absorption and a gradual substitution by new bone, and this substitution does not always take the shape and form of the displaced bone. Second, because such implanted bone larger than 8 cm. x 5 cm. has, as a rule, undergone necrosis. Third, because bone which remains in connection with the periosteum and implanted undergoes an immediate reparation wherever the circulation has been in no wise disturbed. This condition is best obtained where the continuity of the bone has been the least disturbed, and subsequent apposition of the bone flap and skull is the most intimate. (Stieda: *Archiv. fur klin. Chir.,* No. 77; Biagi: *Deutsche Zeitschrift fur Chir.,* No. 65.)

The most successful autoplastic result therefore occurs when the bone edges are cleanly cut, are cut with a very narrow slit, and are slightly bevelled. This will bring the replaced bone in perfect apposition with the surrounding skull and dura, and will avoid any pressure upon the brain by reason of the bevelled edges.

Sixthly, For the general result hæmorrhage is a most important element. It should be quickly controlled in order that time may be saved.

Our method of operating is as follows:

A preparatory treatment of one week, if possible, is desired. During this period drugs are given up as far as possible, the bowels are regulated, and the skin and kidneys are put in good condition. If it is possible, a sphygmographic

record of the pulse rate and blood pressure is made during this time. The head is completely shaven, and the measurements for the Chipault cranio-cerebral topography are made and recorded. The skin is then prepared for operation in the usual way. Chloroform is the anæsthetic preferred. The position of the patient upon the table is important. We prefer to have the body inclined at an angle of from 10 to 30°, with the head upward and beyond the end of the table, resting in our special head-support, which permits of a further change of the head without difficulty. At the side of the table an assistant applies to the wrist some form of blood-pressure apparatus, and records during the operation the pulse rate and the degree of blood pressure. The operator and the anæsthetist can, by watching the needle, record the blood pressure, and best inform themselves of an impending shock. The operator can decide in this manner the necessity of a two-stage operation. He can thus avoid some of the 25 per cent. of sudden deaths which follow operations upon the brain. (*American Journal of Medical Sciences*, 1904, p. 320.)

A tourniquet is applied surrounding the head, just above the ears. This may consist of an inflatable rubber tubing or be a simple rubber tubing tied or held by a fastening. If the tourniquet is not used, a large number of compression forceps are at hand and, as each limb of the incision is cut, an assistant compresses this side until the vessels are clamped and tied. Instead of ligatures a buttonhole stitch may be applied over the cut edges of the skin, aponeurosis, muscle and peritoneum. If one desires, the clamps applied to the vessels may be left without tying until the conclusion of the operation. A recent important addition to this subject has been the application of Kredel's steel plates (*Centralblatt fur Chirurgie*, No. 43, 1906). So far we have not had an opportunity to make use of them, but they appeal to us as very simple and practical. Our incisions expose a ▽ shaped flap. Each limb or third of the incision is made with a single stroke of the knife to the bone, in order that the vessels be readily exposed for ligation. A hoe-shaped periosteum elevator is now used and the perios-

teum is raised beneath the flap for a distance of 1 cm. upon all sides. The periosteum surrounding the flap is also pushed back for 2 cm. This gives, when the retraction is complete, a broad area for the cutter and saw. By raising the periosteum beneath the flap for 1 cm. and applying the cutter and saw near the reflected margin of the periosteum an excess of periosteo-musculo-cutaneous flap is obtained, and the subsequent suture line of the flaps does not coincide with the incision in the bone. (Curtis.) Our retractors are now inserted and the field is prepared for the cutter. This is applied to the bone at each corner of the flap, and the dura is exposed. The depth of the several holes is ascertained by the measure. Whenever the disparity between two holes is over 2 mm., that is, 3 or 4 mm., it is best to interpose one or more holes, and ascertain whether it is an abrupt or gradual incline. In this manner one can tell whether he should saw straight through, should bevel or should change the guard upon the saw. This makes the procedure safe, and it does not delay the operation to any extent. As the depth of the holes varies, it is our practice to saw the deeper parts at first with a saw guarded for 2 mm. less than the depth. This saw passes straight through between holes having the same depth. When the holes having a smaller depth are approached, one must either change the guard or diminish the depth by bevelling. If such disparity exists between two holes, we saw at first straight through and then gradually incline the saw so that a ledge is left upon the skull which supports the bone flap. We find that to slant the saw sufficiently to eliminate a difference of 2 mm. in depth is about all that we can do nicely and with certainty. When greater disparity in depth exists, the angle formed by the saw and the skull will be 45°, and this is not very easily maintained. A disparity of 1 to 2 mm., however, is overcome by slanting the saw from 10° to 30°, which can be done with accuracy and ease. If one prefers, one can change the guards more frequently, but it is scarcely necessary except for marked irregularities, for depressions from Pacchionian bodies or when passing over sinuses. In some parts of the skull, as the

temporal fossa near the zygoma or the cerebellar fossa, where the muscular tissue is very thick, or wherever we intend to sacrifice bone, we may substitute for the saw our toothed fraise which, though it cuts a rather broad slit, nevertheless answers the purpose admirably.

An osteotome is now inserted in the slit, and a few strokes of the hammer, unless the bone is very thick and has been imperfectly sawn, will crack the vitreous plate. The plate is now raised and broken at its base with a spud-like instrument. The base will break evenly across provided the two holes at each extremity of the bone have clearly divided the internal table. I have never seen the slightest injury result when the holes have perforated the internal table, provided the base is less than one-half of the greatest width of the flap and is not thicker than 4 mm. At this time hæmorrhage from the bone will require some attention. We use for this purpose either a crushing forceps upon the bleeding sinus in the bone, or plug it with decalcified bone, cut in the shape of a match, or with Horsley's wax. The flap, including the bone, periosteum, muscle and skin having been reflected and wrapped in a sterile towel to protect it from injury or infection, the dura is exposed and its pulsation or want of pulsation is noted. If wanting, we suspect the cause to be either adhesions between the dura and the arachnoid, exudates, pus or blood between the membranes, severe contusion of the brain or tumors near the cortex producing anæmia of the overlying brain.

We must determine, if possible, which of these conditions is probable, and then proceed to the formation of our dural flap. This flap we usually incise along three margins of the bone, leaving enough for a subsequent suture when the dural flap is replaced. Usually the uncut side is the one which has the larger vessels. With the retraction of this flap the brain is exposed. At this time, the pressure being relieved, there may be a marked fall of blood pressure, as shown by the sphygmographic tracing. If this is the case, the operation may be postponed, after replacing the bone flap, for two to seven days, or until a time when the circulatory equilibrium is restored.

If we are to proceed with the operation, the procedures for the removal of the disease or the tumor will vary necessarily according to the kind and extent of the pathological process. (See individual cases.) After the disease or the tumor is found and removed, hæmorrhage is carefully checked. And we find it best in all cases to tie the arteries with catgut, to use hot water at 115° or gauze held in contact with the bleeding surface, when the hæmorrhage is capillary. When it is venous we apply sutures where the sinuses are involved, and where it is simply a venous oozing we reduce the chloroform and administer oxygen, as suggested by Horsley (loc. cit.). We have also found that the application of Cargile membrane to the raw surface of the brain tends to check the slight oozing remaining after the larger vessels have ceased bleeding. The hæmorrhage being carefully controlled, the dura is sutured and the bone is replaced. The drill holes, where the operation is an aseptic one, are sufficient for drainage, but when this is not the case, or drainage must be extensive, these openings may be enlarged by cutting away the bone opposite the bone flap. The bone flap when replaced fits accurately and cannot be driven in even when forcibly pressed upon. The periosteum and muscle are sutured by a single suture. Our drainage when used is the cigarette drain. The skin is sutured over them, and an aseptic dressing is applied. The head is fixed and is held slightly elevated above the level of the body.

This is our technique in autoplastic operations upon the skull, and we employ it in every instance. Our flaps must be so planned as to expose the several lobes of the cerebrum as well as of the cerebellum, on one or both sides, and consequently we will so describe them.

Frontal Lobes.—Disease or tumor involving the frontal lobes, as well as tumors of the hypophysis, demand an exposure of both sides at once, unless the symptoms point distinctly to one side. The exposure should be sufficient in all instances to give access to the upper, lower and lateral surfaces of the lobe in any case, no matter whether one or both sides are to be exposed. Again, if motor symptoms are combined with

symptoms of purely frontal involvement, the exposure must include the ascending frontal and possibly the ascending parietal convolutions. If the symptoms localize the disease to one side, the incision necessary to expose the three frontal convolutions upon their anterior and lateral aspects must include the area bounded by the depression between the frontal bosses and the superciliary ridge, the prærolandic line and the median line. The base of this flap and the line of breakage in the bone we make in the temporal fossa above the zygoma, where the bone is the thinnest. Our incision commences one finger's breadth from the median line, usually midway between the glabella and the superciliary ridge. It passes outward parallel to this ridge until the temporal ridge is met, where it descends towards the zygoma, ending just above it. The second incision passes from the commencement of the first, parallel to the interfrontal and sagittal sutures, as far as the prærolandic or Rolandic line, depending on the extent of the localizing motor symptoms. The third incision passes from the termination of the second toward the external meatus, ending just above the lobe of the ear. The flap is larger or smaller, depending upon the extent of the motor symptoms combined with the psychical.

This, to be sure, brings an incision directly across the forehead above the orbit, but I believe it is better to have this scar than to attempt to avoid the scar and risk breaking into the frontal sinuses, thus complicating the wound treatment. If one wishes to avoid the scar the line of breakage may be made at the upper level of the frontal sinuses. In this case, the supra-orbital and frontal arteries will supply the flap. We prefer, however, to have the line of breakage in the thin squamous portion of the temporal bone, and to have our arterial supply from the temporal arteries. After these incisions are made to the bone, the hæmorrhage is controlled Retractors are inserted at the angles of the wound, and the cutters are used. One hole is made at each extremity of the second incision, one at the temporal ridge, one at each extremity of the first and third incisions where the line of breakage

is to take place. We usually content ourselves with these five openings unless the distance between them is greater than 3 to 4 cm., or the disparity in the depth of the skull is more than 3 or 4 cm. In the latter case we prefer to drill one or more holes to ascertain the depth and to know where to saw straight through, and where to bevel or to use a smaller saw. As soon as the sawing is completed the bone flap is raised and broken in the squamous portion of the temporal bone. There are usually one or two veins from the longitudinal sinuses and the sphenoparietal sinus which bleed, but these can be easily and quickly secured as soon as the bone flap is raised. In some instances the frontal sinus is opened, but one can be reasonably sure of avoiding it by making the incision nearer the glabella than the superciliary ridge. Sometimes when the bony wall of the sinus is exposed its muco-periosteal lining remains intact. Even if it be opened, it can be drained and packed by cutting away a part of the anterior wall. (Duret: "Les Tumeurs de l'Encéphale.")

During the formation of the periosteo-osseous flap, the time consumed and the failure to stop hæmorrhage may result in a marked diminution of the blood pressure, and presage an impending collapse. To avoid such a result, the operation should be terminated, the wound packed, and the patient placed in bed and treated symptomatically. Within seven to fourteen days the operation is resumed and completed. When resumed, the bone flap is reflected, and palpation of the dura mater determines the degree of intracranial pressure, as well as the difference in the consistency of the underlying tissues. This can be rendered more appreciable by raising the patient's head and diminishing the intracranial blood pressure and tension in the dura, as suggested by von Bergmann. Observation again gives the changes in the color and often the location of the diseased area from the want of pulsation in the dura. The dural flap is now incised upon three sides of the quadrilateral area exposed by the bone flap, selecting for the base of this flap the most vascular part. If the frontal sinus has been opened, we make the base of this dural flap at this side

PLATE VIII.—1. Superior frontal convolution. 2, 3. Middle frontal convolution. 4. Inferior frontal convolution. 5. Points to vertical limb of the Sylvian fissure. 6. Points to the præcentral sulcus. 7. Points to the ascending frontal convolution. 8. The fissure of Rolando. 9. The ascending parietal convolution. 10. Fissure of Sylvius (the first temporo-sphenoidal convolution is shown just below the fissure). 11. The dural flap.

of the quadrilateral space. This flap exposes the three frontal convolutions, superiorly and laterally. It exposes in front the ascending frontal convolution, the Rolandic operculum, the Sylvian fissure, and the first temporo-sphenoidal convolution as far as the parietal operculum. If the incision is made just behind and parallel to the præcentral sulcus instead of just behind and parallel to the Rolandic, then the Rolandic operculum and the fissure of Rolando mark the posterior boundary of the exposed area. By retracting outward the internal surface of the frontal lobe may be seen. By raising the frontal lobe the inferior surface may be palpated and seen. Von Bergmann removed an angiosarcoma successfully in much this same manner.

This is a good type of exposure (Plate VIII), and is the one to be preferred where the lesion is one-sided, in the frontal lobe, encroaching upon the sensory motor area. This will include tumors or disease involving the anterior part of the first, second and third frontal convolutions, tumors of the frontal lobe encroaching upon the posterior part of the first and second convolutions or ascending frontal convolution in which, to the frontal symptoms, are added gradually, motor disturbances involving the trunk, the head, neck and eyes or speech. Tumors of the white substance, with marked psychical disturbances and later intermittent motor symptoms, are also accessible. By raising the frontal lobe, one can obtain a view of any tumor present upon the inferior surface of this lobe. These tumors have been described by von Bruns, by Dupré and Devaux. By retracting outward the frontal lobe, the median surface can be partially exposed, and the first frontal convolution upon the median surface can be seen. Tumors situated in this frontal convolution, and especially in its anterior half, have been quite easily removed, and we may cite here a case of Labbé (Société Anat., 1896, p. 762).

In this region of the brain I have had 15 cases. Of these cases, only 7 are available, since we do not wish to include any cases unless we have heard from them at several long intervals following their operation, or, in case of death, have

obtained an autopsy. The operative recovery of a case has but little significance unless functional restoration accompanies it.

CASE I.—B. C., March 6, 1891, Roosevelt Hospital. Discharged April 13, 1891. Male, twenty-four years of age. *General symptoms*: Vertigo; mental torpor, almost unconscious periods; intense headache. *Localizing symptoms*: Paresis of right arm; motor aphasia; agraphia. *Diagnosis and location*: Compound fracture, subdural cyst or adhesions. Ascending frontal and posterior part of third frontal. *Operation*: Trephine; removal of bone with rongeur forceps; replacement of flaps without bone. *Result*: No cyst; adhesions found binding pia, dura and brain substance. Removal. Improved greatly; died in 1893 without a return of symptoms. Could walk and write well; no aphasia.

CASE II.—M. A. N., March 11, 1892; discharged April 29, 1892. Male, thirty-two. *General symptoms*: Double optic neuritis. Vision lost in right eye five years ago. Injury to skull twelve years ago. Gradually increasing frontal headache and mental apathy. *Localizing symptoms*: Convulsive movements in right arm, head and neck. Distinct aura of nausea preceding each attack. During all attacks all sounds are exaggerated. No loss of consciousness. *Diagnosis and location*: Cerebral traumatic cyst, posterior part of the second frontal and ascending convolutions. *Operation*: Large trephine and rongeur forceps over the fronto-parietal region. Dura incised, nothing found. Second trephine over the external angular process of frontal bone—dura incised, nothing found. *Result*: Not improved. Fifteen months later patient died, and autopsy showed a traumatic cyst, situated over the posterior part of the second frontal, ascending frontal and parietal convolutions. This cyst communicated with the lateral ventricle.

CASE III.—S. I., May 16, 1893. Roosevelt Hospital. Discharged June 27, 1893. Male, fourteen. *General symptoms*: Headache, gradually increasing after injury three years ago. *Localizing symptoms*: Convulsive movements in face, neck and arms. No loss of consciousness. *Diagnosis and localization*: Traumatic cyst or adhesions, the result of the compound fracture over the frontal and parietal lobes. *Operation*: Horseshoe flap trephine to the side of the ¾-inch cicatrix between dura and

scalp. Removal of cicatrix and exposure of the pia mater. Traumatic cyst found, containing 2 drachms of fluid. Removed entire. Flap replaced. *Result*: Patient improved. No attacks for sixteen months. Lost sight of until May 3, 1900. No return of symptoms at that time.

The first of these three cases is interesting in that without more than a removal of the adhesions and a perfect wound healing a perfect functional result took place. The second and third cases are of interest in that in one the cyst was not found and the patient ultimately died, probably as a result of it. While in the other the finding and removal of the cyst resulted in both an operative and functional recovery. In both traumatic cysts the injury and the gradual progression of the headache, the repeated attacks of convulsive movements, the trouble of vision, and the mental apathy, pointed strongly to the diagnosis and location.

CASE IV.—Mrs. F., admitted July 13, 1894, Roosevelt Hospital. Discharged August 27, 1894. Female, forty-six. *General symptoms*: Headache, more in frontal region than elsewhere. No other general symptoms than mental apathy. Injury to frontal region ten years ago. Symptoms present five years. *Localizing symptoms*: Frontal headache, local tenderness to percussion over a swelling 3¾ cm. in diameter in lower half of left frontal bone. *Diagnosis and localization*: Intracranial dermoid, cholesteatoma or a sarcoma of the frontal bone over the second and third frontal convolutions. *Operation*: Omega-shaped flap including the periosteum. Bone removed by the rongeur forceps. Removal of cyst and contents entire. *Result*: Patient made a complete recovery. Was seen in 1900, February 1, and was then in perfect health. *Diagnosis*: Cholesteatoma.

This case, which has been reported as an intracranial implantation dermoid (ANNALS OF SURGERY, Feb. 26, 1896), showed the characteristic appearances of a cholesteatoma (Ewing). The relation of trauma and the tumor render such a diagnosis very probable. (*Deutsche Zeitschrift fur Chir.*, p. 361, vol. lxx.) This condition is rare, existing three times in

10,000 autopsies (Benda). It is very difficult to distinguish from traumatic cysts, since the relation of trauma and the slow progression of the symptoms are the same in both. In order to obtain a cure a very complete extirpation of the capsule must be made, for, although they are not malignant, they will recur.

CASE V.—Admitted September 12, 1906. Discharged September 15, 1906. Hudson Street Hospital (Dr. Connor). Male, forty. *General symptoms*: No previous history. Unconscious; general convulsions (thirteen in twenty-four hours); stertor; pulse 100; temperature 102°; respiration 24. Reflexes exaggerated. Spinal fluid. No meningococcus. Blood examination, 50,000 leucocytes, 93 per cent. polynuclear cells. Urine negative. *Localizing symptoms*: None. *Diagnosis and localization*: Possible abscess of the brain. *Operation*: None. *Result*: Died without regaining consciousness and with symptoms of hypertension of brain and infection. Temperature ranged between 103°–108°; pulse, 100–152; respiration, 24–48.

Autopsy: Autopsy shows that the organs other than the brain are in good condition. In the brain is situated a hydatid cyst, with a firm but non-adherent capsule occupying the internal and anterior portion of the first frontal and the greater part of the second frontal convolutions. It extends backward to the ascending frontal convolution, but does not displace it, nor does it displace the third frontal convolution. It compresses the posterior part of the first and second convolutions more in the depth than appears superficially. The tumor displaces, but does not invade these convolutions (Dr. Elser, pathologist New York Hospital). The position of the cyst is such as would give no localizing symptoms other than frontal headache, mental apathy, inaptitude for work, and mental inattention. Apparently this was the case until the symptoms of hypertension, unconsciousness and generalized convulsions took place. At this time he was admitted to the hospital, with the meagre history of his headache and gradually increasing torpor. Such cases are mentioned (Estaves and Herrega Vegas, *Chipault Chir. Nerv.*, 1903, p. 881). In this particular case our frontal flap would have exposed it, and not being adherent, it could have been removed easily with its fibrous capsule. See Plate IX.

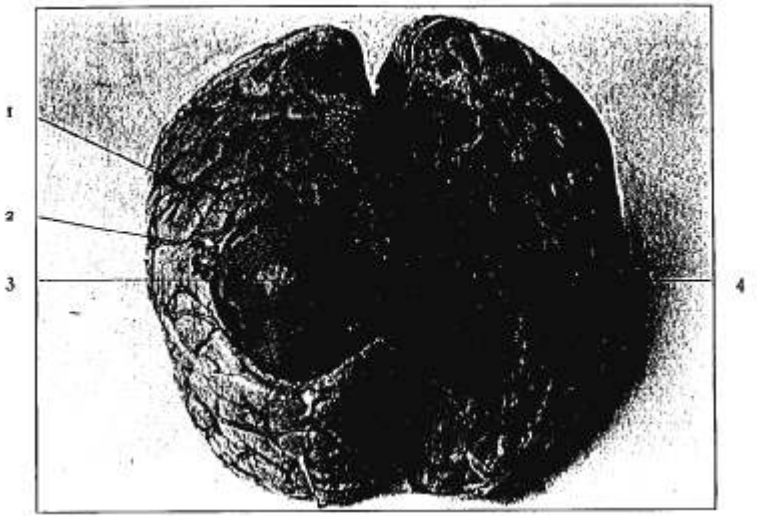

PLATE IX.—Case V. Hydatid cyst. 1. Fissure of Rolando. 2. Præcentral fissure. 3. Cyst. 4. Præcentral fissure.

CASE VI.—New York Hospital. March 22, 1906—March 26, 1906. Male, twenty-seven. *General symptoms*: Old injury to head. No fracture. Three months severe headache. Patient found unconscious in street with convulsion of left side (face, neck and arm). Convulsions during next three days became general. Double choked discs. Babinsky present. Increasing stupor. *Localizing symptoms*: Intense frontal headache, convulsions limited to face and arm—none of the muscles of the head, neck or eyes. *Diagnosis and localization*: Condition at first thought to be due to nephritic poison, later diagnosis of sarcoma or glioma of the face and arm centre in the prærolandic area. *Operation*: None. *Result*: Died.

Autopsy.—The skull cap is unusually thick and heavy. Dura: the external surface is normal. Tension is increased and more marked on the right than on the left side.

The superior longitudinal sinus is normal. The dura is adherent to the pia at one spot over the right frontal lobe; otherwise the internal surface is normal.

Leptomeninges are markedly congested. At one point corresponding to the situation of the tumor described below, the pia is slightly thickened and adherent to dura. The convolutions are flattened and that portion of the right hemisphere situated in front of the præcentral fissure is enlarged and somewhat distorted. The internal surface of this portion of the right hemisphere bulges distinctly, causing a corresponding depression on the inner surface of the opposite hemisphere.

An irregularly spherical tumor, measuring 6 x 5 x 4¾ cm., is found in the substance of the right frontal lobe situated immediately beneath the pia, to which it is attached over an area the size of a half dollar. From this point the tumor projects downward into an excavation in the substance of the frontal lobe. This cavity has the general shape of the tumor and measures 8 x 6 x 6 cm. The space intervening between the tumor and surrounding brain substance is filled with a clear serous fluid. This cavity extends backward to a point on a level with the præcentral fissure, but does not encroach upon the anterior central convolution. Downward it extends to within a few mm. of the anterior horn of the lateral ventricle; outward and forward to within 2 to 2½ cm. from the surface of brain, and inward to within 1 cm. of the mesial aspect of the hemisphere. The internal surface of the

cavity is smooth and traversed by a fine network of injected blood vessels.

The tumor is covered by a distinct capsule, and presents on its surface a meshwork of large injected blood vessels. Its consistence is moderately firm. The cut section is smooth, somewhat mottled in appearance, very vascular, reddish areas alternating with irregular grayish-yellow translucent hyaline areas. The brain substance itself is œdematous. The basilar vessels and basal venous sinuses are all normal.

Microscopic examination of this tumor shows it to be an angio-endothelioma. Dr. Elser, pathologist, New York Hospital.

CASE VII.—New York Hospital. April 10, 1906—April 17, 1906. Male, ten. *General symptoms*: Three weeks ago injury to right side of head. Four days later severe headache and nosebleed, and some twitching of left hand on admission. Marked headache. Complete paralysis of left arm, weakness of left leg. No sensory disturbances. Knee jerk absent. No ankle clonus. Epigastric and cremasteric reflexes diminished, left side. Contusion of scalp over right parietal bone. No ecchymosis. *Blood examination:* leucocytes 12,600 to 8,600; polymorphonuclears 83 per cent. to 74 per cent.; temperature 99.8 to 100.2; respiration 76 to 46. *Localizing symptoms*: Marked headache. Evidence of injury. Paralysis of arm and weakness of leg. *Diagnosis and localization:* Encephalitis, subcortical; Rolandic area, upper and middle thirds. *Operation:* Consent not given. *Result:* Death with increasing stupor.

Autopsy.—The organs other than the brain are normal. Brain: the anterior two-thirds of the right hemisphere is enlarged, swollen and œdematous; the convolutions are flattened. At a point in the posterior part of the right superior frontal convolution is a small irregular perforation which communicates with an abscess cavity, situated in the subcortical white substance, beneath the posterior half of the first and second frontal convolutions. This cavity is filled with a thick creamy pus and measures 2 inches in its transverse and 1½ inches in its vertical diameter. The outer margin of the pyogenic membrane lining the cavity is fairly well defined. The abscess is situated just anterior to the Rolandic fissure, with the exception of the subcortical projection fibres of the arm centres. It does not encroach upon the basal ganglia.

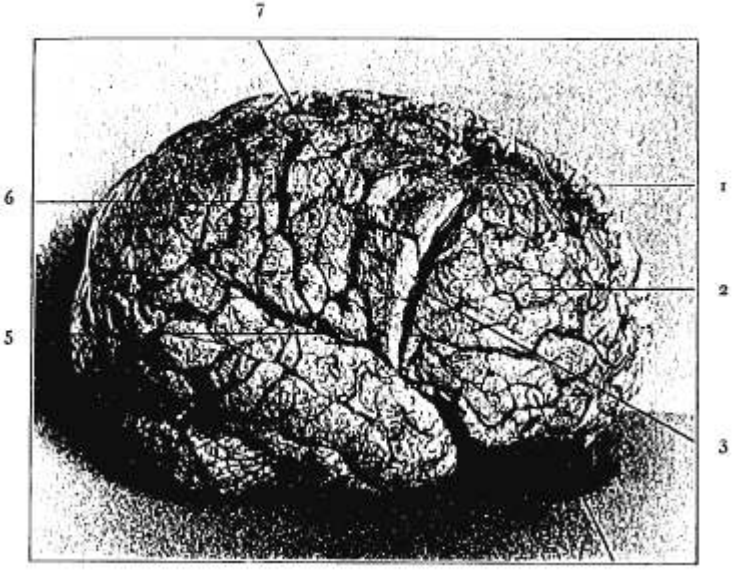

PLATE X.—Case VI. Angio-endothelioma. 1. Tumor. 2. Second frontal convolution. 3. Incision into brain, exposing the lateral aspect of the tumor. 4. Third frontal convolution. 5. Sylvian fissure. 6. Rolandic fissure. 7. Præcentral fissure.

PLATE XI.—Case VI. Angio-endothelioma. 1. Tumor removed from the brain. 2. Middle frontal convolution. 3. First frontal convolution. 4. Anterior horn of lateral ventricle. 5. Displaced first frontal convolution. 6. Rolandic fissure. 7. Præcentral fissure. 8. Ascending frontal convolution.

The location of the tumor is the posterior half of the first and second frontal convolutions extending into the longitudinal fissure. In the depth it extends further posteriorly than is apparent from the photograph. The first and second frontal convolutions have been compressed, but not invaded by the tumor. The ascending frontal convolution has been slightly compressed superficially, but the main compression is below the cortex, in the *corona radiata* and white substance. As observed by those who saw the earlier convulsions, they were limited to the face and arm, without involvement of the muscles of the eye, the head or the neck. Upon admission, the convulsions became general, and no distinctive involvement of the posterior part of the first and second convolutions was observed. The case is characterized by an old injury, with fracture, intense local and frontal headache, and convulsive movements limited for a time to the face and arm (not well observed), and finally general convulsions.

It is to be deplored that the earlier convulsions could not have been more accurately observed, and an early operation attempted.

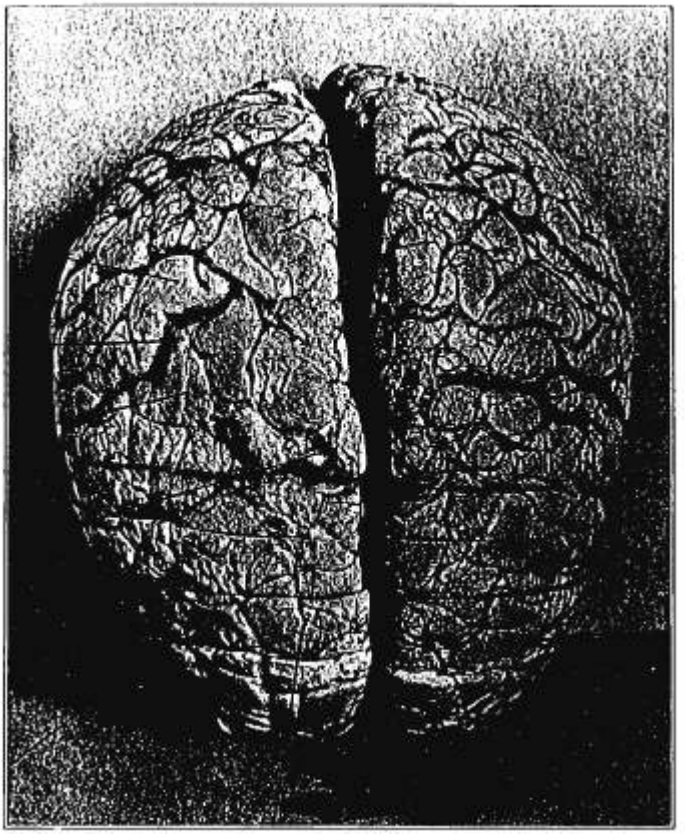

PLATE XII.—Case VII. Encephalitis with abscess. 1. Ascending parietal convolution. 2. Rolandic fissure. 3. Ascending frontal convolution. 4. Tract of infection from the fracture of the skull. 5. Third frontal convolution. 6. Second frontal convolution. 7. First frontal convolution.

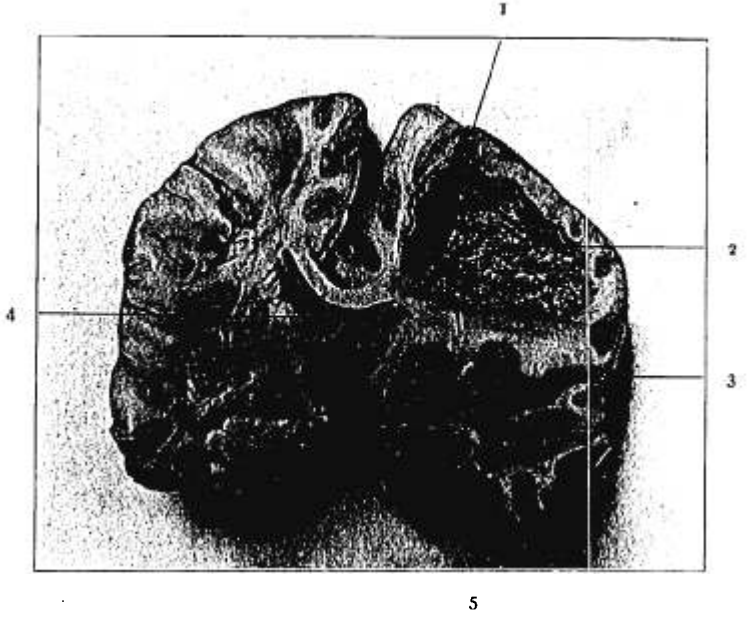

PLATE XIII.—Case VII. Encephalitis with abscess. 1. Track of infection from the fracture in the skull. 2. Contents of abscess cavity. 3. Fissure of Sylvius and Island of Reil. 4. Lateral ventricle. 5. Descending horn of the lateral ventricle.

The bone directly over the perforation communicating with this subcortical abscess is contused (ecchymosis) and shows a compression fracture involving the diploe with a linear crack in the internal plate, beneath which the dura is adherent to the pia. Except at this point, there is no evidence of a pachy- or leptomeningitis.

Bacteriological Examination of the Pus.—Film preparations show many very long chains of streptococci, apparently in pure culture. Cultures from the pus reveal a pure culture of the streptococcus pyogenes.

Ante-mortem cultures made from the spinal fluid remain sterile. No evidence of any sinus or ear disease. Dr. Elser, pathologist, New York Hospital.

The characteristic symptoms here are, (1) The injury to the skull; (2) The severe headache localized to the parieto-frontal region; (3) Tenderness on percussion over this region; (4) The slow pulse rate, 46 to 76; (5) The temperature, 99° to 100°; (6) The blood examination, 8,600 to 12,600 leucocytes, 74 to 83 per cent. of the polymorphonuclear lymphocytes; (7) Microscopic and bacteriologic examination of the cerebrospinal fluid; (8) Focal symptoms limited to the arm and leg; (9) Increasing cerebral hypertension without evidence of meningitis. These symptoms were noticed two and a half weeks after the injury, and continued with increasing stupor and choked discs until death. They were preceded by headache, nose-bleed and slight cortical irritation involving the hand centre, commencing four days after the injury and gradually increasing until admission to the hospital two and a half weeks later. It is to be deplored that an operation could not have been done. Both sides of the frontal lobes must be exposed in most tumors situated in the neighborhood of the optic chiasm, the beak of the corpus callosum, and the internal surface of the frontal lobes (Goldenarm and Winkler, "Chir. Nerv.," Chipault, 1902) or upon the supra-orbital surface of the frontal lobe (Dupré and Devaux, "Iconogr. Salp.," 1901, Bruns, Neurol., *Centralblatt*, 1898).

Two methods of operation have been proposed for this region. Both are cadaver operations.

1. Kiliani (ANNALS OF SURGERY, July 1904), recommends for tumors of the hypophysis cerebri a flap with a pedicle just beyond the coronal suture, its sides just beyond the temporal ridges, and its lower border following the usual curve of the frontal sinuses; that is, 1.5 cm. above the orbital margin of the frontal bone externally, near the temporal ridges, and 3.75 cm. above the root of the nose in the median line. This method has its base of 8.75 cm. for its blood supply in the parietal bone at the convexity of the skull where the bone is the most curved and is the thickest. This means that to break it where one wishes, the pedicle must be weakened and somewhat narrowed. Kiliani's operation, however, has the great advantage of following, so far as one can, the margin of the frontal sinuses, and of giving a good exposure without opening the sinuses. The operation is, however, done with a fraise, and the slit left does not allow complete apposition of bone, so that the bone flap rests upon the dura mater, and the healing cannot be so exact as when the bone is in apposition.

2. Duret ("Les Tumeurs de l'Encéphale," 1905), recommends a flap with its pedicle 6 cm. wide, 1.5 cm. above the supra-orbital margin. Its base is situated beyond the coronal suture; its sides extend beyond the temporal ridges. Its arterial supply is through the supra-orbital and frontal arteries. The frontal sinuses are not infrequently opened, a fact which Duret thinks of little importance, as they can be drained. Duret's operation is done with the Gigli saw and the Marion guide. We cannot agree that the opening of any mucous sinus communicating with the nose is an immaterial thing, and we therefore prefer Kiliani's idea of circumventing the sinuses. Our method, we think, gives as good a field as either of these, and, at the same time, allows a ready breakage in the bone at its thinnest portion, namely, the temporal fossa. Our cutters and saws divide the thickest parts of the bone very easily, and for this reason we always make our pedicle (in all flaps) in the thinner sections of the bone.

3. Our flap is a double one, each side of which is made much in the same manner as our flap for exposing one side of the frontal region. Our pedicles are situated in the thin bone of the temporal fossa. Our incision begins externally to the temporal ridge in the neighborhood of the stephanion, crosses the ridge 1.75 cm. above the orbital margin, that is, just above the superciliary ridge, ascending gradually (Kiliani) until a point is reached 3.75 cm. above the root of the nose. Here the incision crosses the median line and descends in a similar manner to a point beyond the temporal ridge, corresponding to the point of commencement. Another incision is now made across the vertex, about 12 cm. long, situated in front of the præcentral line and behind the coronal suture. This line begins and ends just to the side of the temporal ridge. Another incision bisects these incisions just to one side of the median line. Hæmorrhage is arrested by ligature of the arteries, by the buttonhole suture or by the tourniquet. The periosteum is retracted, and the cutter is used. One hole is made at the temporal ridge near the stephanion on each side. One hole at a point 3.75 cm. above the root of the nose, to each side of the median line. Four holes in the upper incision, two at 1 cm. to either side of the median line, two at 4 to 5 cm. in the temporal ridge,—that is, at the extremities of the upper transverse incision. In the vertical incision, to one side of the median line, one hole is made. No more holes are necessary unless the disparity in depth is great between two holes. In that case, another hole may be made to determine the depth. As we usually select a saw 2 mm. less than the actual measurement, we always have a fair margin of safety which we can greatly increase by a bevel. After the bone is sawn, the smaller of these two bone flaps is removed by an osteotome inserted at the point where one noticed that the bone was less divided than elsewhere,—that is, at the thicker portions of the bone. One or two strokes of the mallet upon the osteotome loosens the flap and then it can be raised and broken at its pedicle in the temporal fossa. The other bone flap may be broken in the same manner after loosening the longitudinal

sinus. After the flaps are raised, the dura is exposed and the bleeding from the vessels in the longitudinal sinus are tied. Inspection of palpation of the undivided dura is made. If shock is impending, the operation is discontinued, and is performed in two stages. If so, the bone flap is replaced over gauze packing, and in from seven to fourteen days the operation is renewed.

At this time the procedure will vary, depending upon whether the tumor or cyst can be appreciated upon one side, or whether both sides must be exposed with the dural flap. If one side alone, a dural flap, with its base at the longitudinal sinus, is sufficient. If both sides, or the orbital face is to be exposed, the longitudinal sinus is ligated close to its attachment to the ethmoid and the falx cerebri is divided (Kiliani). The incision in the dura is carried laterally, following the margin of the bone incision, with the base above. The dural flap is raised, spoon retractors are introduced, and the two frontal lobes are raised, exposing at first the olfactory bulbs and the optic chiasm, and later the anterior and middle cerebral arteries between and behind which the hypophysis cerebri is seen. Further back than this level the opto-peduncular space can be seen, though it cannot be reached. Laterally, the orbital surface of the frontal lobes is exposed. Kiliani has looked over 42 cases of tumor involving the hypophysis cerebri, a large number of which were cases of acromegaly, while others were tumors of the pituitary gland, but without symptoms of acromegaly. In no instance have these tumors been removed. In Kiliani's own case the enormous vascularity forbade any such attempt. In 3 cases reported by Horsley the tumor has been successfully removed, with one recurrence (*British Medical Journal*, August 23, 1906). Likewise in the opto-peduncular space, though four tumors have been diagnosticated before death, and found on autopsy, none have been removed.

For tumors and disease of the anterior fossa arising from the bones, the falx or the meninges, this method of incision allows an opening at first upon one side and then upon the other, if necessary. In this manner the operation per-

formed may be accomplished at one sitting, and upon one side if limited and diagnosticated correctly. If extensive, and involving both sides, the bilateral flap may be cut at once. It may be done at one or two stages.

I have had but one case involving this region, and requiring the exposure of both sides at once. This case is Case VIII.

Case VIII.—H. S. January 30, 1906. Discharged March 17, 1906. Male, thirty-three. *General symptoms*: Eighteen years ago fell and injured skull in frontal region. Seven years later severe headache over the injury occurred. One year ago button of bone was removed, and later two pieces of dead bone. Symptoms of severe headache and pressure beneath the scar remained. A gradual change in his character took place, in which he showed signs of moral perversion. *Localizing symptoms*: Injury, frontal region, headache. *Diagnosis and localization*: Pressure from adhesions. *Operation*: Large quadrilateral flap, base 3 cm. above supra-orbital margin, involving both sides of skull, 9.5 cm. transversely, 7 antero-posteriorly. A thick, dense mass of adhesions involving both frontal lobes (over longitudinal sinus and the first and second frontal convolutions). Removal, Cargyle membrane and replacement of flap. Implantation of celluloid plate, 9.5 x 7 cm. *Result*: Recovery. Relief of headache immediately. Primary union except one small spot where the skin flap necrosed. Secondary plastic. Discharged March 17, 1906. No subsequent changes in moral tone. Headache relieved. October 10, 1906, still healed, no headache, no moral change. January 1, 1907, still free from headache; no other change.

Upon the lateral aspect of the brain the cortical centres for motion, sensation, motor aphasia, word-blindness, or word-deafness and hearing are included in the posterior third of the frontal, the ascending frontal, the ascending parietal, the superior and inferior parietal, the supramarginal, the angular and the first and second temporo-sphenoidal convolutions. This includes:

1. Tumors and disease involving the superior Rolandic and præcentral lobe, a region especially predisposed to the tuberculomata.

2. It includes tumors of the middle Rolandic area (Duret, p. 225, loc. cit.).

3. Tumors and disease of the inferior Rolandic area.

4. Tumors and disease involving a part of the superior parietal convolutions.

5. Tumors and disease involving the inferior parietal convolution and the supramarginal convolution.

6. Tumors and disease involving the first and second temporo-sphenoidal convolutions, in their central and posterior portions.

Tumors and disease under 1 involve the lower extremity; under 2, the upper extremity; under 3, the face, language, and movement of the jaws especially; under 4, alterations in the superficial and deep sensibility are marked symptoms; under 5, astereognosis and deep sensibility are particularly involved; under 6, disturbance in hearing is a marked symptom, and upon the left side, in addition, we have manifestations of sensorial aphasia, except in left-handed people. On the right side sensorial aphasia is wanting, except in left-handed people. We bound this region by an imaginary line, including the posterior half of the frontal convolutions in front, the median line above, the second tempero-sphenoidal sulcus below and the occipital lobes behind. This area includes the whole sensory-motor area which, in order that the flaps be not too large, may be divided into two regions—the motor-sensory or anterior half, and the sensory-motor region, the posterior half. These two regions may, when the necessity arises, be exposed by one flap. But when the symptoms are definitely motor and then sensory, or first sensory and then motor, the anterior or posterior portions may alone be exposed.

It is our practice, unless symptoms are definite, to expose this region by one flap, but we will describe this operation in two flaps. The first flap is bounded by a vertical line one finger's breadth in front of the prærolandic line anteriorly and by a vertical line marking the parieto-occipital fissure, which fissure is found at the posterior extremity of the Sylvian line. The base of this flap is the squamous portion of the temporal

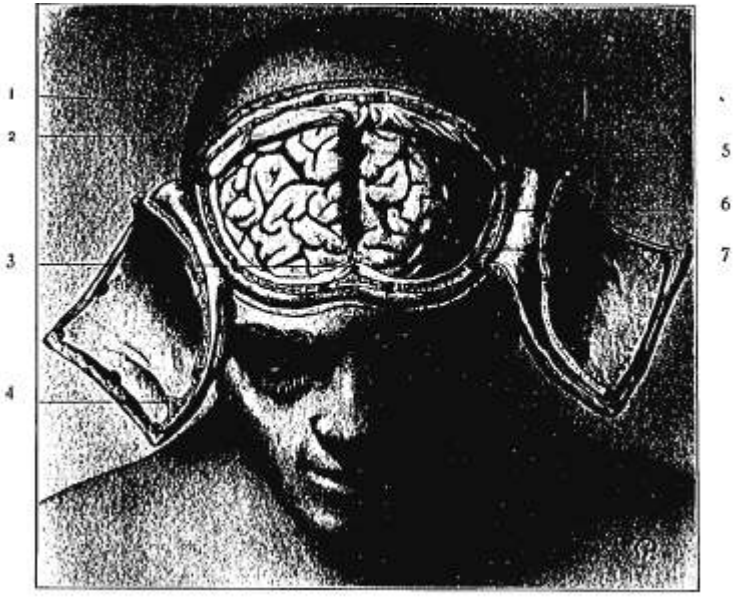

PLATE XIV.—1. Superior longitudinal sinus. 2. Dural flap (rolled up). 3. Superior longitudinal sinus. 4. Frontal crest. 5. Superior frontal convolution. 6. Middle frontal convolution. 7. Inferior frontal convolution.

PLATE XV.—1. Ascending frontal convolution. 2. Præcentral sulcus. 3. Ascending limb of the Sylvian fissure. 4. Inferior parietal convolution. 5. Fissure of Rolando. 6. Ascending parietal convolution. 7. Supramarginal convolution. 8. Fissure of Sylvius. 9. Superior temporo-sphenoidal convolution. 10. First temporo-sphenoidal sulcus. 11. Second temporo-sphenoidal convolution.

bone. The incision is usually commenced upon the anterior and posterior limits. This is followed by the incision 1 to 1.5 cm. from the median line, uniting the upper extremities of the other incisions. Usually, four to six holes are drilled, and measured. In addition to these two or three holes may be drilled to determine any variation in the depth of the skull between these openings. It is not necessary to drill all of these holes, as the second two or three are only for the purpose of determining any great variation in the thickness of the skull. Because of the Pacchionian bodies, these extra holes are sometimes important in the line between the upper extremities of the first incisions. They are equally important at the margin of the temporal ridge, since the variation in depth not infrequently ranges from 1 to 10 mm., and one must know where to bevel and where to saw straight. The bone flap having been sawn, is raised and broken in the temporal fossa. The dura is inspected and palpated and a flap cut. Our flap has usually been with its base above. This is reflected after the middle meningeal artery is tied. It often does not bleed after separation of the dura from the bone if some compression is exerted. If it does not stop, it can be easily ligated. No fear should be had for this artery; no more so, indeed, than in the extirpation of the gasserian ganglion, where it is practically neglected as a factor for or against any particular method of procedure. After reflection of the dura, the field exposed is seen in Plate XV. This, as we can see, gives a full view of all that is necessary about the motor area and, provided localization has been fairly accurate, it should give one sufficient adjacent exposure to correct any slight error. The question of a subcortical or cortical tumor can be best determined, providing the area exposed is extensive.

The number of cases operated upon in this region, of which we have definite information, is 15: 4 traumatic cysts, 1 non-traumatic cyst, 3 cases of adhesions following depressed fracture of the skull or laceration of the brain; 1 endothelioma, 1 gliosarcoma; 1 laceration and hæmorrhage; 4 cases of exploratory operation. The number operated upon but of

which we have no definite knowledge, either by autopsy or examination, longer than one year after operation, is 13.

CASE IX.—A. T. M., Roosevelt Hospital, October 6, 1892–December 26, 1892. Male, twenty-one. *General symptoms*: Injury to head fourteen years ago, followed by aphasia and hemiplegia of right side for eight months. Slowly improved and for seven years was well, speech being slow and hesitating. Seven years ago first convulsions, limited to right side at first, then general. During seven years, convulsions have slowly increased in frequency. *Localizing symptoms*: Injury over motor area. Paralysis with recovery, followed by Jacksonian epilepsy, slowly increasing in severity. No sensory disturbances. *Diagnosis and localization*: Hæmorrhage and cyst. Rolandic area. *Operation*: Trephine and chisels. Omega-shaped osteo-periosteal flap, exposing centre of Rolandic area. *Result*: Cyst found 1½ inches in diameter between dura and pial coats. Dissected away, and flap replaced. Small trephine opening used for drainage. Patient seen 1901, still free fron convulsions.

CASE X.—J. H., January 5, 1892, Roosevelt Hospital. February 28, 1892. Single, fourteen. *General symptoms*: Ten years ago fracture of left parietal bone, following which an abscess developed and was incised. Fifteen months ago fell again and struck old spot. This was followed immediately by petit mal. Aura began by numbness in right hand, then flexor spasm in right arms and leg. Such attacks have been repeated frequently (Dr. Starr). *Localizing symptoms*: Aura and Jacksonian attacks in arm and leg: *Diagnosis and localization*: Cyst, result of subdural hæmatoma. In the middle and upper part of Rolandic area, rather posterior than anterior. *Operation*: Quadrilateral-shaped osteoplastic flap removed with chisels over the posterior part of Rolandic area, 8 x 6 cm. Two small communicating cysts removed, situated between the brain and the dura and pia mater. *Result*: Discharged February 28, 1892. Readmitted January 6, 1893. Six months ago convulsion in right side recurred. January 7, again operated and a small cyst removed from original site, including a wedge-shaped mass of brain and scar tissue. Drained. Discharged February 10, 1893, no recurrence of symptoms. In 1889 patient died of pneumonia without at that time having had a recurrence of the convulsion.

CASE XI.—B. C. November 22, 1893, Bellevue Hospital. Discharged December 17, 1893. Male, thirty. *General symptoms*: Fourteen months pistol shot in right parietal bone; ten days later paralysis of right arm and leg, no loss of sensation three and one-half months; gradually recovered. For ten months slight Jacksonian epilepsy, limited to right arm and leg, preceded by headache (severe). *Localizing symptoms*: Depression at site of an old scar, 3.75 x 1.25 cm. The centre of this scar is over the Rolandic area. Jacksonian attacks. *Diagnosis and localization*: Traumatic cyst or adhesions without cyst. *Operation*: Flap, osteoplastic—exposing Rolandic area. Bone found adherent to dura. Beneath it a small cyst found holding 10 c.c. and a small spiculum of bone from the inner table. Removal of wall and drainage. *Result*: Recovery. Discharged December 17. In 1901, heard from; still free from Jacksonian attacks.

CASE XII.—H. F. S., New York Hospital. Admitted February 23, 1905; discharged March 14, 1905, cured. Male, twenty-six. *General symptoms*: When five years old, fell and drove a nail into right side of head. Nail was immediately removed, but during the healing the entire left side of his face and body became paralyzed. This paralysis gradually disappeared, and he was perfectly well for five years, when he began to have epileptic attacks, at first once in every four or five weeks. Attack began by twitching left corner of mouth, then neck, shoulder, elbow, wrist, fingers, thumb, side of body and leg. Sometimes loses consciousness, other times does not. Never falls, has to lie down sometimes; bites tongue. Frequency steadily increased, occurring both day and night, and became so bad that four years ago he was trephined and a cyst removed from brain. No attacks for six weeks, when convulsions began again. For last two to three weeks has two or three attacks both day and night. Between attacks he is perfectly well. *Localizing symptoms*: Scar on right side of head—old trephine. *Diagnosis and localization*: Traumatic epilepsy. A cyst. (Dr. Spitzka.) *Operation*: Osteoplastic flap, quadrilateral in shape (3 inches to a side), exposing the site of old operation. Skull thick, 7 to 10 mm. Dura opened by a crucial cut over site of old injury. Multiple cysts found in region of posterior central convolution. These extended 4 cm. (1½ inches) below surface of brain. All cysts evacuated, fibrous cyst wall dissected out as completely as possible. Hæmorrhage easily

controlled by slight pressure. Dura stitched back in place; small gauze packing at upper posterior angle of wound to control oozing and for drainage. *Result*: Cured. Drain removed on fifth day. All sutures out by eight day. All dressings off on thirteenth day. Left hospital on seventeenth day. Wound solid, primary union. Has had no convulsions. For eight days after operation, temperature 99° to 103.4°, pulse 88 to 120, respiration 18 to 24, then a gradual return to normal. Seen October, 1906. No return of symptoms.

The characteristic points in these cysts seem to be the long period between the original injury and the operative interference, during which time there was progressive increase of the symptoms, from the headache, the paresis or the convulsive attacks and apathy at the times of the injury, to the development of the more pronounced symptoms of cerebral hypertension.

The three stages of such cysts are marked in our 4 cases: The traumatism, epileptic seizures or spasmodic hemiplegia, and the period of intracranial hypertension. Of these 4 cases, 3 were cured, and 1 was unimproved.

CASE XIII.—I. T., New York Hospital, May 10, 1899–July 10, 1899. August, 1900–January 1, 1901. Female, aged thirty-four. *General symptoms:* Nine years ago began to have epileptic seizures, repeated three or four times a year, lasting three or four minutes. Attacks became more severe and more localized in right side of face and right arm. No injury. At present the convulsions are continuous, lasting for days at a time, with but slight intervals. Loss of consciousness. *Localizing symptoms*: Localized, right-sided facial and brachial convulsions (Dr. Peterson). *Diagnosis and localization*: Possible tumor situated in lower third of Rolandic area. Cyst holding 3 drachms found, opened, cut away and drained, communicating with small opening in lateral ventricle. Drainage was excessive and cure tedious. Cured for thirteen months. Return of convulsions. January 1, 1901, second operation, cyst found with many adhesions. Fifteen days after operation convulsions ceased, *i.e.*, with the removal of the drainage and the complete healing

of the wound. *Operation*: Quadrilateral flap from præcentral line to Sylvian line posteriorly, and from the Sylvian line to 1 cm. of median line. Rolandic area exposed. *Result*: After second operation the convulsions were limited to slight twitchings of arm and face at long intervals; this continued for one year, when they became more general, about one a month. (No cure.)

This was a cyst, so far as the history can be obtained, of non-traumatic origin. It communicated by a very small opening with the anterior portion of the ventricle, and was situated beneath the third frontal and ascending frontal convolution. I have always believed that this cyst was of congenital rather than traumatic origin, since no traumatic history has been obtained. It is remarkable that during the drainage, and after the first operation, the convulsions were at long intervals, and consisted of only slight twitchings of the face and of the arm. This continued for one year, when the attacks recurred. Upon reopening the operative field, the remains of the cyst were found, together with many adhesions. Drainage was again employed and relief for about one year occurred, at which time the patient died in a severe convulsion, and no autopsy could be obtained. In some respects, this case is similar to those cases reported by Kocher (*Deutsche Zeitschrift fur Chir.*, 1893).

The following are 3 cases of adhesions:

CASE XIV.—G. N. June 13, 1902–July 7, 1902, New York Hospital. Single, twenty-one. *General symptoms*: Injury to right side of head eight years ago. Two years ago first fit, next year two fits, next year three fits. These, as observed, consisted in Jacksonian attacks, confined to the hand and face. During last two years these attacks have become more general, and are attended with loss of consciousness during last year. *Localizing symptoms*: Injury—Jacksonian attacks. *Diagnosis and localization*: Adhesions or cysts. Middle Rolandic area. *Operation*: Osteoperiosteal and muscle flap, 8 x 6 cm., exposing area. Centre of flap is slightly depressed and the seat of old depressed fracture. Well marked adhesions below dura and brain. Removed. Rubber tissue inserted. Depression in bone (3 x 2 cm.) cut out, and cel-

luloid implantation. *Result:* Discharged July 7. Improved. Improvement only temporary—three months fit recurred. No further operative investigation. No further information.

CASE XV.—R. W. New York Hospital. October 25, 1892–December 10, 1892. Single, male, aged twenty. *General symptoms*: One year ago injury to head, left parietal region; was unconscious for several hours, unable to speak, and right hemiplegia for one hundred and forty-two days. Recovered and began to have slight twitchings, limited to hand, arm and leg. These have continued at intervals. *Localizing symptoms*: Jacksonian attacks. Old scar and depressed bone. *Diagnosis and localization*: Depressed bone with adhesions. *Operation*: Omega-shaped flap, skin, muscle and pericranium. Trephine and rongeur for bone, elevating the depression; pieces saved and replaced. Adhesions removed between dura and brain. *Result*: Recovery from operation. No improvement in condition, although patient feels better and speaks better, but the same conditions persist. Though a lesion was found and removed, it must have been imperfectly done, as the same conditions have recurred.

CASE XVI.—W. B., waiter. New York Hospital. February 19, 1906–March 12, 1906. Male, forty-seven. *General symptoms:* Injury to head eighteen months ago. Unconscious at times and for one-half hour. Was operated on for fractured skull; healed in three months. For two or three days after injury, motor aphasia (slight and only when excited did he have difficulty in speaking the word). For eight months has had some irregular sensations, as ringing in ears, spots before eyes, nervousness and paraphasia (motor). Feeling of numbness in right hand and at times inability to hold tightly any object. *Localizing symptoms*: Paraphasia, numbness of right hand below wrist and in foot up to the ankle (Dr. Spitzka). Scar with depressed bone in the frontal and parietal region, 4.75 x 2 cm. *Diagnosis and localization*: Old compound depressed fracture, adhesions and pressure upon brain, rather than a traumatic cyst, involving middle of Rolandic area (Dr. Spitzka). *Operation*: Osteoperiosteal muscle skin flap, exposing the middle Rolandic area from frontal lobes to centre of parietal lobes, *i.e.*, from præcentral to Sylvian lines, and from tempero-sinusal line to 2 cm. from sagittal suture. Transverse diameter of flap is

8 cm. Flap raised with dural adhesions. Dissected away from the pia mater and skull and skin. The space devoid of bone and the pia and brain exposed by removal of adhesions, covered by Cargyle membrane and celluloid plate perfectly shaped—February 24. *Result*: Primary union, March 12. Discharged. Patient feels well and notices no difficulty in pronouncing words which he could not before. Is less nervous. April 27, 1906, no aphasia; working daily. October 17, 1906, no aphasia, full strength in right hand; working daily.

These 3 cases represent injuries with adhesions, and with or without depression of the brain. In one case the possibility of a traumatic cyst was great, though none was found. The remaining cases consisted alone of adhesions. The case of complete recovery was the slightest and the most recent case. It is interesting to observe also that in this case the Cargyle membrane was used to replace the area bared by the removal of the adhesions, and a celluloid plate was inserted into the area bared by the removal of the bone.

The next case was an endothelioma.

CASE XVII.—E. R. New York Hospital. March 25, 1905. Discharged April 25, 1905. Male, forty. *General symptoms:* One year before small tumor, sarcoma removed from inner canthus eye; recurred and again removed. Three months ago began to forget words, and two months ago to use words incorrectly. Severe frontal headache, nausea and occasional vomiting; two weeks ago paralysis of right arm for fifteen minutes and aphasia. Morning of admission became unconscious; some aimless movements and twitching of right arm. Several small subcutaneous tumors exist on the trunk. *Localizing symptoms*: Paralysis of right arm and aphasia for fifteen minutes, followed later by twitching movements in same area and gradually increased pressure. *Diagnosis and localization*: Endothelioma, middle part of Rolandic area. Dr. M. A. Starr. *Operation*: Flap described for anterior part of lateral surface, 10 cm. x 8 cm., duration fifty-three minutes. Tumor found as diagnosticated by Dr. Starr. Tumor measures 3.75 x 3.12 x 2.6. Cavity lined with Cargyle membrane and closed.

Result: Uninterrupted recovery. Discharged April 22. Mental powers, can talk, eat, walk well. Microscopic examination, melanoma of endothelial origin. Patient continued in good health for thirteen months; returned to hospital with multiple deposits in abdominal organs and skin, especially in the liver. He died from these without recurrence in brain.

It is to be noted that this patient remained free from all cerebral involvement up to the time of his death, which occurred thirteen months later, and that his death was due to the involvement of other organs than the brain. It may also be noted in this case that the large bone flap, 10 cm. x 8 cm., with a skull of moderate thickness, 5 to 7 or 8 mm., an exact focal diagnosis and an encapsulated tumor required but fifty-three minutes for its removal from the time of the incision to the replacement of the bone flap after suture of the dura.

The next case was a gliosarcoma.

CASE XVIII (Gliosarcoma).—I. S. New York Hospital. October 17, 1903–December 28, 1903. Male, 48. *General symptoms:* December, 1902, suddenly a convulsion, and could not speak for some time afterward. Nephritis being found, the convulsion was considered uræmic. February, 1903, second convulsion. March, 1903, third convulsion—fixation of jaw, peculiar sensation on right side of face. Mental confusion, but no loss of consciousness. Several such attacks have since occurred, involving muscles of eye, right side of face, loss of power of speech, and then right hand twitches and tingles. No loss of consciousness. June, 1903, Dr. Peterson saw him. October 2, 1903, Dr. Starr saw him. Jacksonian attacks still exist from time to time. He has become mentally dull, with an ataxia of right hand. Eyes normal. *Localizing symptoms*: Jacksonian attacks limited to the eye, face and hand. *Diagnosis and localization*: Tumor in lower third of Rolandic area, extending forward to third frontal convolution. *Operation*: October 20, 1903, flap for exposure of Rolandic region made. Flap measured 10 x 8 x 3 cm. Duration one and one-fourth hours. Cystic tumor found as diagnosticated by Dr. Starr. Removed. Measured 5 x 5 and 2½ cm. Cyst wall removed in part. Cautery

to bleeding vessels. Slight gauze packing. October 29, 1903, flap raised. Cyst wall completely removed with brain tissue. Drainage and reclosure of wound. *Result*: Cystic glioma. Discharged December 28, 1903. Mental condition improved. Walked well, talked fairly well in spite of removal of brain tissue. June 12, 1904, readmitted with recurrence and paralysis of upper extremity complete and slightly of lower extremity. Reopening of wound and recurrence. Recovery from operation, but paralysis again appeared. Died January 12, 1905.

In this case it is to be regretted that such an operation could not have been performed at an earlier date. Though the cyst was enucleated, apparently entire, and care was taken in this enucleation, nevertheless a recurrence took place in twelve months, requiring a second and more extensive removal of the growth, with death during the second year, with further increase of the growth.

The next case was one of laceration and hæmorrhage.

CASE XIX.—E. K.; Roosevelt Hospital, May 7, 1891. Discharged June 23. Female, fourteen. *General symptoms:* Fell 25 feet, striking head. Stupor, not unconscious. Pulse 130, respiration 15. Pupils normal. Three hæmatomata, scalp—one over left parietal, one over right parietal, one over right frontal. Paralysis of right arm, leg and face. Aphasia, motor and sensory(?). *Localizing symptoms*: Injury, paralysis of right arm, leg and face. *Diagnosis and localization*: Subdural hæmorrhage, with pressure from blood clot and laceration of brain. *Operation*: Two days after injury, omega-shaped flap, exposing fracture over left parietal bone. A flap with fractured bone (8 x 4 cm.), chisels used. Extensive subdural hæmorrhage. No extensive laceration of the brain. Replacement of flap, and readjustment of bone fragments. Closed. Recovery. *Result*: Wound closed, June 23. Discharged. Speaks and can use right arm and leg. Seen one year later, still in fine condition. A letter received May, 1903, stated her continued good health.

The foregoing case speaks for the immediate operation as soon as the patient recovers from the shock. The com-

pleteness of the cure, and the want of subsequent symptoms referable to this laceration, speak in favor of the early operation.

The following cases were cases of exploratory operation:

CASE XX.—C. E. L. New York Hospital. October 20, 1901. Discharged November 11, 1902. Female, twenty-seven. *General symptoms:* Tubercular family history. Old purulent otitis externa one month ago. Tonsilitis purulent two years ago. Otherwise healthy. Two months ago, without apparent cause, peculiar tingling sensation in left face, leg and arm, followed by loss of power in same. These last a few hours to two days, and are followed by pain in neck back of mastoid. Ringing in head and deafness in right ear, which has a large perforation. Double optic neuritis, more marked in right eye. Tactile and temp. sense normal. Temperature and pulse 100°–112. *Localizing symptoms:* Tuberculous history. Ear disease, followed by sensory and motor disturbances in Rolandic area. *Diagnosis and localization*: Tubercular meningitis or tuberculoma. *Operation*: Omega flap over the ear, exposing temporal fossa in front and Rolandic area and temporo-sphenoidal lobe; negative. Lateral ventricle punctured and negative. Lateral sinus exposed with burr and found normal. Cerebellar fossa exposed by burr and bone removed. Cerebellum negative. Mastoid cells found normal. As no tumor was found in this case, and as the intracranial tension in cerebellar fossa increased over that in cerebrum, a decompressive operation was done here, and the outer wounds were closed with bone flaps. *Result*: Complete recovery after loss of about one-half cerebellar lobe. Has remained well, and free from attacks; sees better than before operation. Seen October, 1904.

CASE XXI.—Mrs. R. New York Hospital, February 18, 1906–March 3, 1906. Forty-two. *General symptoms:* Six months ago intense frontal and occipital headache; at present numbness and coldness of left knee, leg and finally arm. Difficult articulation. Slight photophobia. Nystagmus in left eye. Tenderness on head over right parietal region. Mentally bright. Pupils equal. No optic neuritis. *Localizing symptoms*: Tenderness over right parietal. Paresis of right face, arm and leg. Increased knee reflex. Many slight spasms in left arm during

examination. Constant paræsthesia of left side. Hesitancy in speech. *Diagnosis and localization*: Cortical or subcortical tumor in right parietal region, upper third, posterior to fissure of Rolando. Fibroma (?) (Dr. Starr). *Operation*: Large quadrilateral flap, bounded by the præcentral and parietal lines anteroposteriorly and from the parietal to the median line vertically. Dura exposed, divided, convolutions exposed and recognized. Palpated, incised and punctured with needle; no tumor found. *Result*: Immediate recovery. No permanent recovery.

CASE XXII.—F. H. December 30, 1905. Discharged February 17, 1906. New York Hospital. Male, twenty-six. *General symptoms*: One year ago vision became blurred. Gradually paresis in back of neck and headache. These increased until June, 1905. Right eye showed choked disc. Occasional vomiting, projectile. Right leg and arm gradually paralytic, with occasional twitching of left face. Gradually became drowsy and more stupid. Antisyphilitic treatment. Two months ago epileptiform convulsions on right side, ending in general convulsions and loss of consciousness. Totally blind two months before admission. Otherwise healthy. *Localizing symptoms*: No localizing symptoms, unless paresis of right leg and arm, with twitching of right face. *Diagnosis and localization*: Tumor of brain. Intracranial hypertension. *Operation*: Temporal region on both sides exposed—dura incised. Search made, no tumor found. Tremendous intracranial tension. Suture of the dura. *Result*: Death two days later. No relief of the symptoms, in fact, convulsions were more frequent after than before operation. Just before death: temperature 105°; pulse 120 to 140; respiration 32. No autopsy.

CASE XXIII.—M. C. M. New York Hospital, March 25, 1904–April 10, 1904. Single, female, twenty-seven. *General symptoms:* Supposed injury to skull. For five years attacks of *petit mal,* with unilateral convulsions in left arm, face and leg, followed by *grand mal.* Aura commencing by pain in the head (right side) and followed by left-sided convulsions confined to arm and leg, with at present complete loss of consciousness. All medicinal and hygienic treatment failed. Family history, alcoholic and insane. *Localizing symptoms:* Involvement of arm and leg, pain in head. *Diagnosis and localization:* No specific diagnosis made. Advised exploration. *Operation:* Large quadrilateral flap made, exposed Rolandic area on right side. Nothing

found. *Result:* No improvement after one month. Considered an idiopathic epilepsy.

CASE XXIV.—H. J. November 30, 1892, Roosevelt Hospital. December 29, 1892. Twelve; male. *General symptoms:* Injury to back of head ten years ago. Two hours later convulsion, lost consciousness. One year ago similar attacks, continuing at times eleven hours. Since then has had an attack once or twice a year, followed by temporary paralysis in right arm, leg, aphasia. Mental condition becoming involved. *Localizing symptoms*: Involvement of right arm, leg and aphasia. *Diagnosis and localization*: Hæmorrhagic cyst. *Operation*: Omega flap exposing Rolandic area. Nothing found upon cortex. Some fluid obtained, 1.75 cm. below the cortex, probably from lateral ventricle. Incision of brain substance revealed nothing. *Result*: Recovery from operation. No improvement. Thought to be an idopathic epilepsy, of which the Jacksonian attacks were but an expression.

These 5 cases were exploratory operations only, the diagnosis being a tentative one. In none of the cases was a tumor found. In 2, decompressive operations were performed. In 1, (Case XXII) a temporal flap was made upon each side, namely, beneath the temporal muscle. This patient died two days later. In the other, with several trephine openings and a removal of the occipital bone covering the cerebellar fossa, a complete recovery was effected, and she is still alive, having lost all the symptoms of her apparent tumor. One case must be looked upon as an idiopathic epilepsy, of which the Jacksonian attacks are but a part. (Mills, loc. cit.) In the remaining 2 cases there was nothing found. The patients at present are in the same condition as before.

The next flap (the posterior half of the lateral aspect) exposes the ascending parietal, the superior and inferior parietal, the outer portion of the cuneus, the supramarginal and angular gyrus, and the first and second temporo-sphenoidal convolutions. It is especially destined for those cases commencing with disturbances of sensibility, followed by some disturbance in motion of the extremities, with a gradual hemianopsia and loss of language, or for those cases of sen-

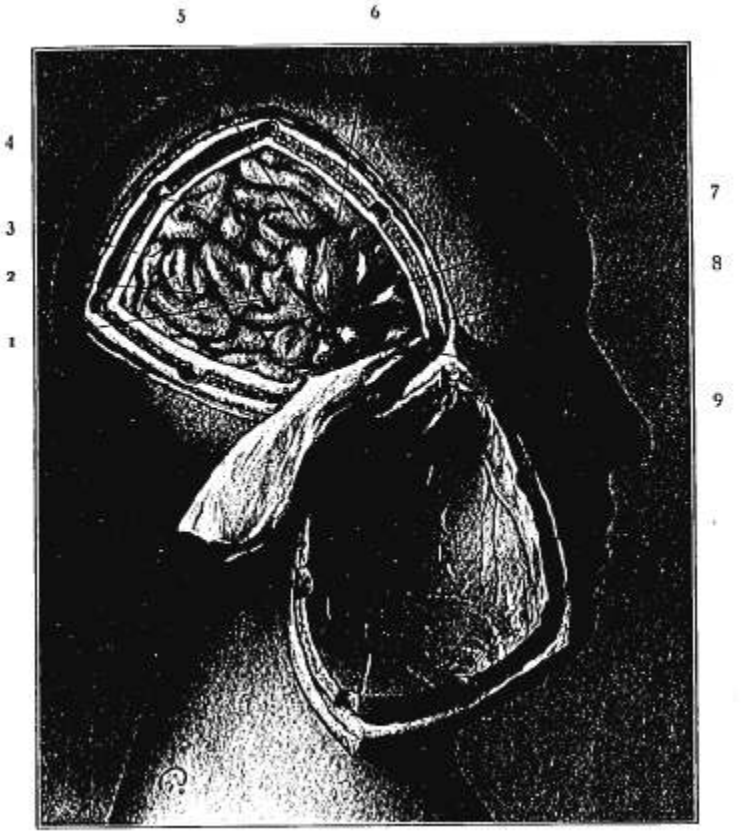

PLATE XVI.—1. Supramarginal convolution. 2. Angular convolution. 3. External parieto occipital fissure. 4. Superior parietal convolution. 5. Inferior parietal convolution. 6. Ascending parietal convolution. 7. Fissure of Rolando. 8 Fissure of Sylvius. 9. First temporo-sphenoidal convolution.

sorial aphasia commencing with hemianopsia. The area for language is perfectly exposed by this flap, and it includes, as we know, the third frontal, the first and second temporo-sphenoidal and the angular convolutions. This flap is, in every respect, similar to the former except in its boundaries. The flap starts usually from the junction of the præcentral line and the Sylvian line in front. It crosses obliquely the Rolandic line to the sagittal suture at a point just behind the Rolandic line. The lower or posterior limit follows the 80 per cent. line of Chipault. These two lines are connected by a line parallel to the sagittal suture, 1 cm. laterally. The base of the flap is in the posterior part of the temporal fossa. See Plate XVI.

CASE XXV.—F. B. January 22, 1904–February 17, 1904. Female, thirty-six. *General symptoms:* Two months ago lost sight of both eyes. Stupid and sleeping most of the time, alternating with excitement, weeping and screaming. This excitement seems due to delusions of various sorts. Eyes: pupils dilated and do not react to light. Right optic disc 2 dioptres; left optic disc ½ dioptre. White swelling. Speech not affected. Motions good in arm and leg. Sensation to touch. Localization delayed in the left side slightly, otherwise negative. X-ray shows a slight shadow near tentorium cerebelli. *Localizing symptoms*: Nothing except the sensory disturbances. These were only slight and were not considered of great value. *Diagnosis and localization:* Probable tumor, endothelioma or fibroma. Probably in occipital lobe. X-ray diagnosis negative. *Operation*: Large rectangular flap, including the left parietal to occipital area from part behind Rolandic area to parietal line. Flap raised. Dura incised. No tumor found, though brain was palpated, incised and punctured. Opening of the opposite side was not permitted, owing to the negative find. Flap replaced without bone. *Result*: Patient grew more excited after operation—tore off dressings. This was followed by an infective hernia cerebri and death February 17, 1904. *Autopsy.*—Right parietal region, an endothelioma, 4 cm., antero-posteriorly, 3 cm. transversely, and 5.5 cm. vertically. Tumor is easily enucleated from the brain except on the mesial side, where it seems to blend with a thin layer of brain tissue.

It seems to arise from the meninges and causes pressure upon the brain. The posterior portion of the paracentral and the quadrate lobe have been obliterated. The upper part of the ascending frontal has been pressed upon severely. The meninges showed a diffuse sero-purulent meningitis, due to streptococcus infection. Location of tumor destroying the quadrate and posterior part of paracentral lobule, and pressing upon ascending parietal convolution, gave only as an indication the disturbance in sensation, and the astereognosis which were only slight, and were not considered marked enough for diagnostic purposes. Had the same incision been made upon the opposite side, it would have exposed the tumor, but the infection of the wound after operation precluded it. See Plates XVII and XVIII.

This tumor does not compress the cuneus nor the cerebellum, and therefore produces no symptoms referable to the cerebellum or the cuneus. (Oppenheim, "Traité," p. 125.) Oppenheim reports a case in which this was the condition. The only marked symptom in our case was the hallucinations, while the less marked symptoms were the slight disturbance in tactile sensations and the apraxia on the left arm and leg.

We have consequently, in the lateral region of the skull, 17 cases, 2 deaths, 7 slightly improved or unimproved, 8 cases cured,—that is, remaining well after one or more years.

Of the 13 cases of which we have no records following the operation, our mortality, due apparently to or at least superinduced by the operation, was 15 per cent (2 cases). Our combined operative mortality in this region is then 13.3 per cent.

In the occipital region the area to be exposed in each instance is that including the cuneus, and the first, second and third convolutions; that is, all the portion of the cerebrum behind the middle of the superior and inferior parietal convolutions. This flap will therefore include the space between the point of meeting of the Sylvian line and the sagittal suture above, the temporo-sinusal line below, the sagittal suture in the median line, and a point one finger's breadth above the posterior root of the zygoma in the temporal fossa.

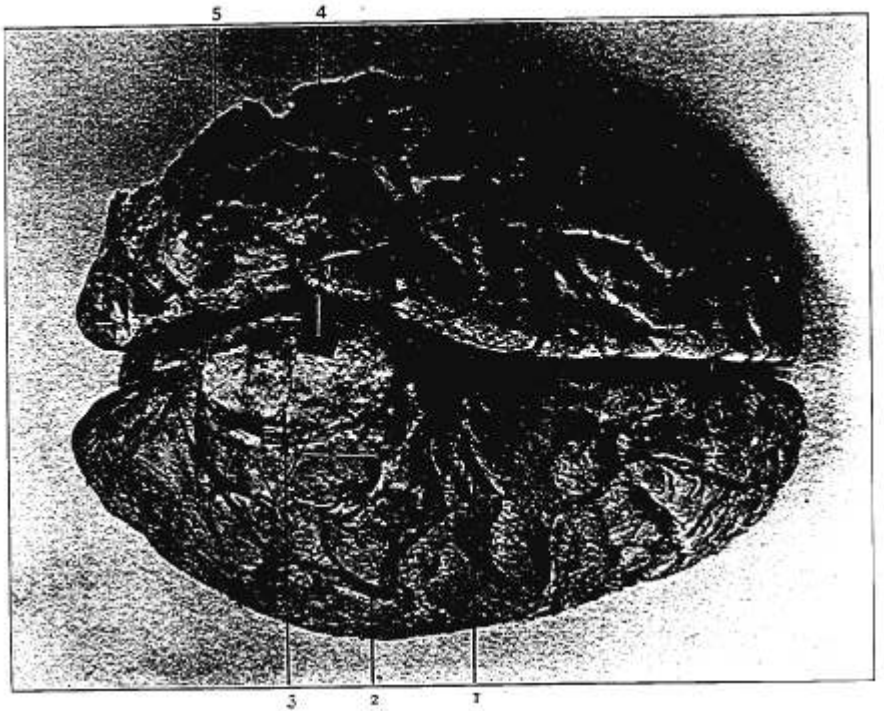

PLATE XVII.—Case XXV. Endothelioma. 1. Rolandic fissure. 2. Sylvian fissure. 3. Tumor and line of section of tumor shown in Plate XVIII. 4. Section taken from tumor for pathological examination. 5. Site of operation.

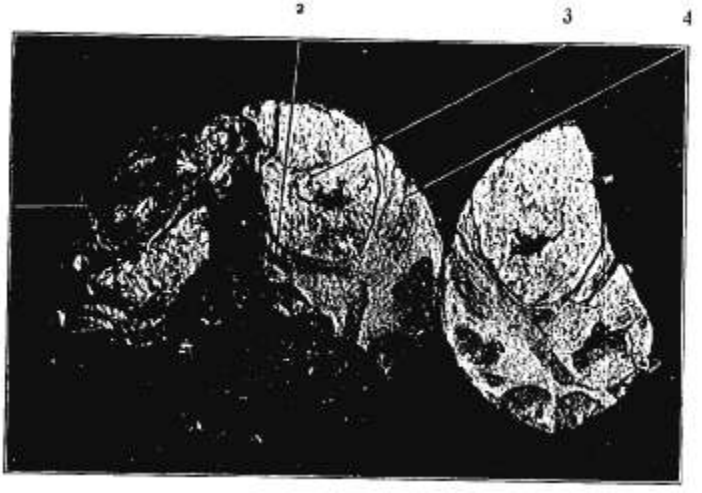

PLATE XVIII.—Case XXV. Endothelioma. 1. Site of operation. 2. Parieto-occipital fissure. 3. Tumor. 4. Sylvian fissure. 2, 3 and 4 show the transverse section of the tumor and brain at the point shown by Fig. 3 in Plate XVII

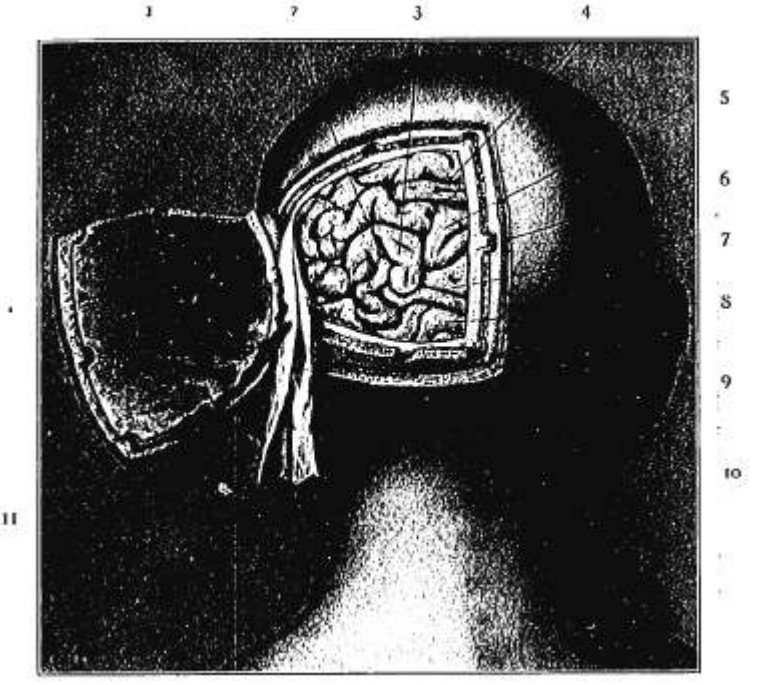

PLATE XIX.—1. Supramarginal convolution. 2. Inferior parietal convolution. 3. Angular convolution. 4. External parieto-occipital fissure. 5. First occipital convolution. 6. Superior longitudinal sinus. 7. Second occipital convolution. 8. Third occipital convolution. 9. Lateral sinus. 10. External occipital protuberance. 11. Dural flap.

In this region of the skull exposed by this flap, we have one case.

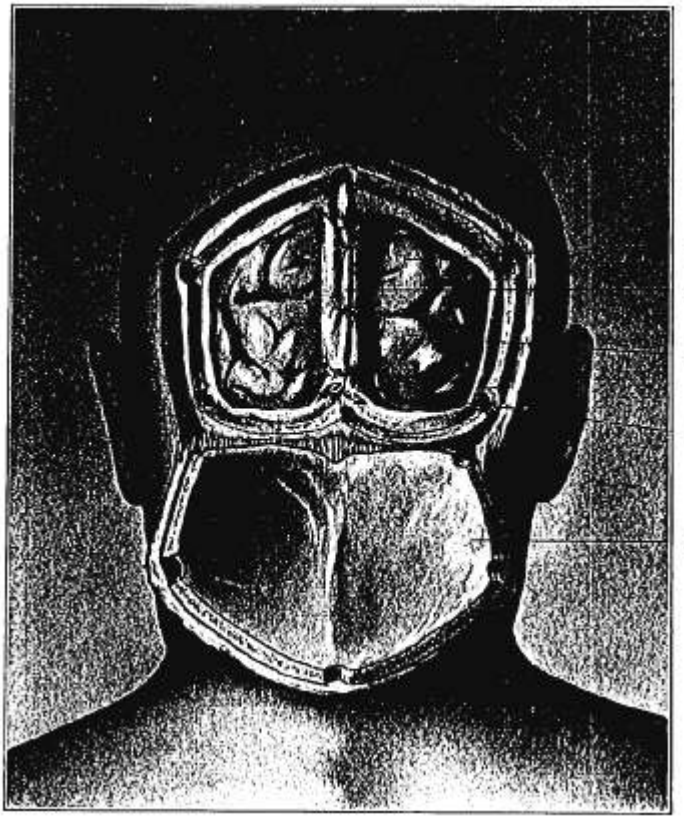

PLATE XX.—1. Superior occipital convolution. 2. Dural flaps. 3. Second occipital convolution. 4. Third occipital convolution. 5. Reflected bone flap.

This form of flap is (see Plate XIX), in our opinion, the best because it exposes the cuneus and lingual lobes, and permits a view of the inferior parietal and angular convolutions, and it may be extended forward at its base if there be any need of exposing the convolutions along the Sylvian fissure. Its blood supply is from the temporal artery, and is good. The bone breaks in the thinnest portion, and the thicker parts of the skull are now divided with the saw. The shape and extent of the flap may be sawn and broken as one wishes, without the danger of having it break at some undesired portion, with the consequent prolongation of the operation, and the increase of shock.

Our incision commences at the temporo-sinusal line in the temporal fossa, near the posterior root of the zygoma above the external meatus. It passes to a point 1 cm. laterally from the median line, parallel to and above the temporo-sinusal line. Here it ascends 1 cm. above the Sylvian line, whence it turns and follows this line until the temporal ridge is passed and the squamous portion of the temporal bone is exposed. The first incision in this flap divides the occipital arteries and they require securing. The second incision requires a ligation of the vessels from the opposite side. The anterior incision comes in contact with the temporal arteries. The hæmorrhage must be secured first, because in this portion of the scalp the vessels are large and bleed to a large extent. For this reason we usually use a tourniquet and often the buttonhole stitch (or the metal plates of Kredel). We usually make seven holes in all: two in the temporal fossa at the beginning and end of the incisions; one each half way toward the median line in the upper and lower incisions; finally, two at the extremities of the first and third incisions, near the median line. After drilling and sawing, the flap is raised. It usually breaks in the temporal fossa, opposite the junction of the posterior and middle third of the Sylvian fissure, so that a perfect exposure of this region is obtained. The posterior branch of the meningeal artery is exposed in the lower angle, and above it upon the upper surface of the dura mater one or two vessels may be

seen, passing into the longitudinal and transverse sinuses. These, however, are not difficult to secure. The dura is usually incised in the line with the bone flap, and with the base towards the temporal fossa. It may have its base in the opposite direction, if one wishes, though we prefer the base to correspond with the base of the bone flap. When reflected there is exposed the posterior portion of the superior parietal, a part of the supramarginal, the whole of the angular gyrus, and the three occipital convolutions. By retraction outward of the brain, the præcuneus, cuneus and part of the lingual lobe may be seen. The enucleation of a growth in this region by this incision would not be difficult, provided it did not involve the lingual lobe where, if it were small, it might easily escape observation; while in the other lobes the same growth may be more easily identified and enucleated. Such a case as this has been recently operated upon in two stages, by Krause, assisted by Oppenheim, and an account of which is given in the *Berliner Klinische Wochenschrift,* Dec. 17, 1906.

The patient was a man of thirty-five years, who, after suffering for some weeks from headache, developed right-sided hemianopsia, optic neuritis of the right eye, vertigo, vomiting, bilateral choked disc most pronounced on the right side, and partial alexia and agraphia. A little later right-sided hemihyperæsthesia, hemiataxia, and hemiparesis developed. It was believed that from the clinical signs the tumor could be located in the occipital region of the left side, and operation was decided upon and performed in two stages three and a half months after the onset of the headache. At the first stage a large quadrilateral bone flap was made over the occipital lobe, exposing the lateral and longitudinal sinuses. Sixteen days later the wound was reopened and the dura incised. The tumor could be immediately seen occupying the lower median angle of the opening made, and it was easily removed by blunt dissection. It measured 32 x 55 x 58 mm., and was egg-shaped. On microscopical examination it was found to be a spindle-celled sarcoma. The second operation lasted only one-half hour and there was little loss of blood, but during several days the patient was in a very precarious condition owing to high temperature and rapid and feeble heart action. He ultimately recovered completely, the only symptoms persisting being a moderate contraction of the right visual field, while otherwise he is entirely free from difficulties.

Case XXVI.—R. M. May 23, 1906; discharged June 3, 1906. Twenty-one; single. *General symptoms*: Day before

admission struck on head with a bale hook. No loss of consciousness. Small punctured wound, 1 cm. long, from which brain matter escapes. Wound enlarged and puncture into brain found. Vomited occasionally; eyeball moves in every direction. Pupils react to light and accommodation, equal, moderately dilated. Homonymous hemianopsia. Four hours after admission became somewhat dull, and complained of headache (frontal). Pulse irregular, slow. Increased tension. *Localizing symptoms:* Homonymous hemianopsia. Injury to skull. *Diagnosis and localization:* Diagnosis, punctured wound of the angular convolution(?) (lobule de pli courbe). *Operation:* Rectangular osteoplastic flap, with base in temporal fossa above the mastoid (burr, drills and saw). Flap raised, exposing the under surface of bone and showing the tearing away of the inner table 2.5 x 2 cm., while the hole was .5 cm. in diameter. Dura torn and lacerated, admitting the finger. Brain lacerated over the angular gyrus and for a depth of 1 inch (2.5 to 3 cm.) The three occipital lobes, the external parieto-occipital fissure and the supramarginal convolution were recognized. The puncture was between these points. Clot removed. Area covered with Cargyle membrane, drainage with gauze. About one-half the bone was removed to facilitate the drainage. Dura sutured. *Result:* May 28, wound closed. Hemianopsia almost gone. June 3, hemianopsia gone.

This case seems to show that a lesion situated cortically at the junction of the occipital, the angular and the inferior parietal lobes, extending 2.5 to 3 cm. in depth, will produce a bilateral hemianopsia, of which the patient was not conscious until his attention was called to it. Then he appreciated distinctly that his field of vision in each eye was limited to the same side as the lesion. The optic radiations of Gratiolet were probably involved.

If both sides of the occipital region are to be exposed at once, it seems to us less of an operation to make a flap including the occipital region below the Sylvian line of each side, with the base at the two temporo-sinusal lines. This form of flap will not make such an advantageous opening for either side; but if both sides must be exposed at once, it seems to offer an advantage over the two separate side openings, in that

there is less drilling and sawing required and consequently less hæmorrhage to be overcome, but the exposure is not so advantageous as is that obtained by the two lateral occipital flaps. Our incisions for the single occipital flap exposing both sides pass upon each side from the junction of the outer and middle thirds of the superior curved line upward and slightly outward to the Sylvian line, at which point they follow this line to the median line, where they meet,—that is, at a point 70 per cent. of the distance from the nasion to the inion. These incisions are carried directly to the bone, the arteries ligated, and the hæmorrhage checked as in all other operations. The drill holes are placed as follows: one on each side, .5 cm. above the tempero-sinusal line, one on each side of the angle of the incision over the Sylvian line, and one on each side of the median line. The saw is used and the bone is broken at the tempero-sinusal line, parallel to the transverse sinuses. The hæmorrhage from the transverse and longitudinal sinuses may be brisk, but it usually may be stopped by pressure or suture with Mata's needles, which I have threaded and ready for use. The dural flaps have their bases at the longitudinal sinus and are reflected over it. The parts exposed are similar to those exposed by the lateral occipital flaps, but not so thoroughly.

Case XXVII.—O. O. New York Hospital, April 21, 1906; discharged May 14, 1906. Male; twenty-one. *General symptoms:* Fell great distance, striking head; was unconscious fifteen minutes. Is stupid, answers questions, but cerebration is slow. Movements of eyeball perfect, pupils react sharply. Is totally blind. No paralysis nor anæsthesia in face, arm or leg. Grip in hands good. Legs contracted with power. Knee jerk not exaggerated. Depression in skull opposite centre of the occipito-parietal suture, with scalp wound 2 inches long. Pulse slow, 60–70; temperature 99.6°; respiration 16–24. *Localizing symptoms*: Total blindness. Depressed fracture over occipital region. *Diagnosis and localization*: Pressure upon occipital lobes both sides by bone and hæmorrhage. *Operation*: Large flap including periosteum formed 8 x 7 cm., exposing the depressed bone, 7 x 7, and circumventing the three occipital

convolutions upon both sides, (*i.e.*) from the Sylvian line above to the temporo-sinusal line below. Bone reincised. Lines of fracture extended to right side toward foramen magnum, loosening the greater part of the occipital bone on that side. Dura injured only over small area. Large subdural hæmorrhage, extending over the occipital lobe and into the longitudinal fissure to the tentorium cerebelli. Dura incised on both sides of longitudinal sinus and clot allowed to escape. Dura sutured and a celluloid plate (7 x 7) moulded to approximate the curvature of the skull. *Result*: April 23, 1906, distinguishes light and darkness. April 24, sees objects moving before eyes. April 25, counts fingers before eyes. April 27, recognizes faces. April 29, can see 50 feet, printed matter with letters 1 inch high. May 14, sight perfect.

If not contraindicated, we prefer after the exposure of one side of this region to add to our lateral flap a similar, though not so extensive flap, upon the opposite side. The hæmorrhage and the sawing necessary to accomplish this may be a little more than is required for the single flap, but it is our opinion that the exposure obtained is worth the risk run and the time expended in making the flap, for the operation may be done under these conditions, in two stages rather than in a single-stage operation.

Such a flap is represented in Plate XXI.

The last two cases, and which were situated upon the occipital region, are important in that they show the necessity of early operation in order to secure rapid recovery and perfect functional restoration. In both of these cases the subsequent perfect restoration was due undoubtedly to the early operation, avoiding the possibility of sepsis, and allowing complete restoration of the brain tissue by the removal of the clot in its substance.

In addition to these cases already reported, we have two more, situated in other regions of the brain, but nevertheless interesting. The first of these cases is the following:

CASE XXVIII.—*Cystic Glioma, filling Third Ventricle and projecting at the Base between the Crura.*—Admitted February 5, 1905, to the New York Hospital, Medical Division (Dr. Loomis). Transferred February 19 to the Surgical Division. Female, eighteen. *General symptoms* (December 4 to 24, 1904): Treated for anæmia and amenorrhœa. Sharp pain in both temporal regions and top of head, followed by unconsciousness, sixteen months ago. Several similar attacks since then. They occur now three times a week and will last often three hours. For the last six months numbness, tingling in hands, arm and feet. Gait unsteady; staggers to both right and left side. During the attacks there is marked projectile vomiting and involuntary urination. No double vision; strabismus. Always has been hard of hearing. *Localizing symptoms*: Eyes: Pupils small, react slightly to light and accommodation. Right optic, disc swollen, central depression lost, margins ill defined, arteries small. Left optic, disc shows the same changes but less marked. Extremities: knee jerks exaggerated; no œdema; no ataxia. Slight Romberg. Staggers more to the right. Ocular muscles are normal. Tongue deviates to the right. Eleven days before she died became totally blind in right eye; vision left eye limited to 5 feet. Exophthalmos gradually became worse. Slight general convulsions appeared. Leucocytes 14,000; temperature 99–100; pulse 96–112; respiration 18–24. General hyperæsthesia. Six days before death eyes became fixed and turned toward left; pupils contracted and inactive. Muscles of right arm and leg spastic; muscles of left arm and leg flaccid. *Diagnosis and location*: Cerebral tumor, localized to right side of pons varolii. *Operation*: No operation. *Result*: Died February 21, 1905, in convulsions.

Histological Examination.—Cystic glioma with hæmorrhage.

Pathological Report.—Base of brain: The tumor with a thickened capsule forms a nodular projection at the base of the brain in the space formed by the crura cerebri and optic tracts. It folds backward over the anterior commissure, to which it is attached. Measures ¾ x 1½ inches. The anterior half of the pons is indented by the growth, but the stumps of the fifth nerve are free and unattached. The third nerves emerge from the crura beneath the growth and are apparently not atrophied; the optic nerves are smaller than normal; the cranial nerves of the medulla are negative; the arteries of the circle of Willis are normal.

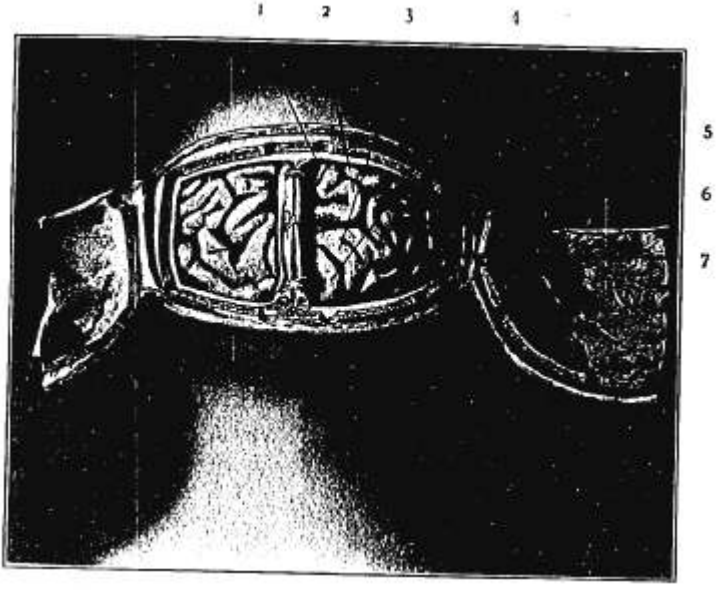

PLATE XXI.—1. External parieto-occipital fissure. 2. First occipital convolution. 3. Second occipital convolution. 4. Third occipital convolution. 5. Angular convolution. 6. Supramarginal convolution. 7. First temporo-sphenoidal convolution.

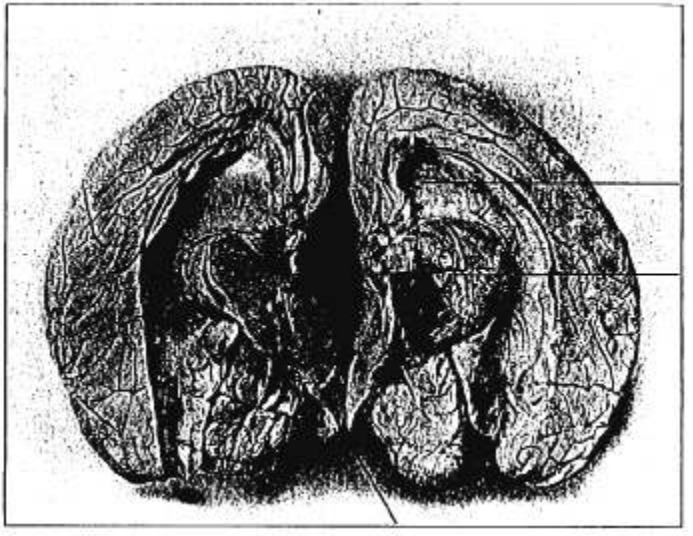

PLATE XXII.—Case XXIX, Glioma. 1. Lateral ventricle. 2. Tumor with hæmorrhagic area. 3. Pons and medulla from which a section has been removed for examination.

Interior of brain: There is a high degree of hydrocephalus; all horns of the lateral ventricle are enormously dilated; the cavity of the third ventricle is completely filled up with tumor mass which rises on either side in the foramina of Munro as whitish eminences. The surface of the growth is smooth and encapsulated. Posteriorly, the growth has compressed the corpora quadrigemina and adjacent portions of the cerebellum. Transverse section through junction anterior and middle thirds of third ventricle reveals a cystic mass with hæmorrhagic areas between the optic thalami. At the circumference there is a margin of whitish translucent tumor tissue sharply circumscribed and more or less encapsulated. The pineal gland and hypophysis cerebri are not distinguishable in the tumor mass. Transverse sections through pons and medulla show only pressure—no infiltration.

"The tumor itself was inoperable, but a decompression would certainly have been of service."—J. Ramsey Hunt.

This case is very similar to one reported by Grenet, except that in his case the pituitary body was not involved by the tumor. (Société Anatomique, 1898, p. 90.) Many cases presenting in the optopeduncular space, are also mentioned by the same author.

Case XXIX.—Admitted New York Hospital, December 12, 1904. Died December 14, 1904. Male, seventeen. *General symptoms:* About one month ago began to have pain and stiffness in muscles back of neck, also frontal headache. These symptoms have gradually become worse. Two weeks ago staggering gait, vomiting and dimness of vision appeared. Is becoming more and more drowsy, is in a stupid condition most of the time. Duration of observation, six weeks. Dr. A. L. Fisk. *Localizing symptoms:* Optic neuritis both eyes, more marked in left in which it started. Partial blindness, drowsiness. *Diagnosis and localization*: Cerebral hypertension from tumor(?). *Operation:* December 13, 1904. Chloroform; scalp and periosteum turned down from left superior curved line, exposing occipital bone. A burr opening was made in this region and enlarged with rongeurs. Cerebellum bulged ¾ inch, little pulsation. Explored with needle and finger, nothing found; needle

then inserted upward through tentorium, also negative. Scalp returned and sutured, rubber tissue drain. Small burr opening then made in occipital bone, opposite side (right side). Cerebellum did not bulge. Needle inserted, nothing found. Scalp returned and sutured. *Result*: Died.

Autopsy.—The opening in right occipital bone is 1.5 cm. in diameter and is in the centre of the right posterior fossa. The opening in the left occipital bone is about twice as large and its upper border corresponds to the lower edge of the lateral sinus. The dura has been opened and softened cerebellar tissue protrudes slightly. The meninges are normal. The cerebral convolutions are everywhere moderately flattened without any appreciable difference in degree in any region. The lateral ventricles are moderately enlarged and contain an excess of serous fluid. Owing to the presence of a soft, partly gelatinous tumor, which is limited to this ganglion, the right optic thalamus measures 5.5 cm. antero-posteriorly, 3.5 cm. transversely, and 3 cm. vertically. There is marked flattening of the inner surface of the left optic thalamus, owing to pressure by the tumor. The posterior and inner part of the growth is the seat of hæmorrhage and the capsule has been ruptured, allowing the gelatinous tumor tissue to escape and partially fill the fourth ventricle. Whether this rupture occurred during removal of the brain or prior to this cannot be stated. Microscopical examination shows the tumor to be a very cellular glioma. The cells are of the small type. There is an abundant vascular supply and the vessels as a rule have very thin walls in proportion to their size. There are small areas of necrosis scattered through the growth.

Though the tumor was a large one and involved the optic thalamus, the symptoms were only those of cerebral hypertension.